THE STANDARD CYCLOPEDIA OF MODERN AGRICULTURE

THE STANDARD CYCLOPEDIA OF MODERN AGRICULTURE AND RURAL ECONOMY

A KENTISH HOP GARDEN

THE STANDARD CYCLOPEDIA OF MODERN AGRICULTURE AND RURAL ECONOMY

BY THE MOST DISTINGUISHED AUTHORITIES AND SPECIALISTS UNDER THE EDITORSHIP OF

PROFESSOR R. PATRICK WRIGHT

F.H.A.S. F.R.S.E. PRINCIPAL OF THE WEST OF SCOTLAND AGRICULTURAL COLLEGE GLASGOW

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LIST OF PLATES

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The classic series of articles on insects by the late John Curtis have been embodied in the work, revised by Professor F. V. Theobald and Mr. Cecil Warburton, M.A., and bear the initials of J. C. and F. V. T. or C. W.

In like manner the great botanical articles of the late Professor John Lindley, which, like Curtis's articles above mentioned, were contributed to Morton's *Cyclopedia of Agriculture*, have, under Professor A. N. M'Alpine's revision, been embodied over the initials J. L. and A. N. M'A.

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Hemlock, Water, a poisonous umbelliferous plant which grows in wet places. See COWBANE.

Hemlock Tree (Tsuga) is a genus of the Abietineæ tribe of the Coniferæ. Of the other genera in this tribe—Pine, Spruce, Douglas Fir, Silver Fir, Larch, and Cedar—the Spruce (Picea) is the most closely allied; but in Hemlock the leaves are petiolated and two-sided, with a single resin duct running along the under side of the leaf, while in Spruce the leaves are sessile and two- or four-sided, ranged along the upper and under rows, and with two lateral resin ducts. In both genera the leaves are persistent for several years. The genus Tsuga comprises six species, three of which are indigenous to North America and three to Eastern Asia. They are evergreen trees with flat or angular stalked leaves proceeding from prominent cushions, and having one resin duct running through each leaf beneath the midrib, scaly buds, lateral male flowers, and terminal female cones with persistent and more or less woody scales. The three North American species are those grown in Britain, viz. the Canadian Hemlock (*T. canadensis*), one of the commonest trees in the eastern woods of Canada, and the two Californian and Oregon species, the Western Hemlock (*T. Albertiana*; but named *T. Mertensiana* by the British Conifer Conference in 1891), and Patton's Hemlock (*T. Pattoniana*), formerly wrongly called the Californian Spruce. The Canadian species was introduced into Britain in 1736, and the two Californian species in 1851 by Jeffrey. The Canadian Hemlock has its leaves irregularly disposed in two rows and has oval cones about ¾ in. long and ½ in. broad, green when young and brown when ripe; while in both the Californian species the leaves are ranged spirally round the twigs, the branches are more pendulous, and the cones are larger, those of the Western Hemlock being oblong-ovate, about 1 in. long, and pale-brown, and those of Patton's Hemlock being cylindrically oblong, 2 to 2½ in. long and about ¾ in. broad, and tapering at both ends, but especially at the top. The Californian Hemlocks yield a much better timber than the Canadian species, the wood of which is of little repute even in Canada. The Western Hemlock has done well as an ornamental tree in Britain. One of the largest specimens is at Hafodanus, in Denbighshire; planted in 1856, it had in 1904 a height of 94 ft. and a girth of 8 ft. 5 in. at breast height. Its value as a woodland tree in Britain has not yet been ascertained by extensive experiments. [J. N.]

Hemp (*Cannabis sativa*, L.) is a representative of the nat. ord. Cannabinaceæ (see CANNABIS), which includes the hop, and is nearly related to the stinging nettle. It is met with wild in Asia from the Caspian Sea to China, and has been cultivated from the earliest times both in Asia and Europe. The greatest value of the plant is in the fibre of its stems, which is made into ropes or woven into sailcloth, sacking, and other coarse fabrics. Its seeds contain 20 to 25 per cent of a bland, tasteless oil, which is sometimes expressed and used for burning in lamps, for soapmaking, and other purposes; they are also extensively employed as food for poultry and cagebirds. Hemp is cultivated largely in the warmer parts of Russia, Germany, Hungary, Italy, Spain, and in the United States. In India, Persia, and other hot countries a narcotic substance similar in its effects to opium is secreted by small glandular hairs on its leaves and stems (see CANNABIS and CANNABINACEÆ).

Many other plants which are not related to *Cannabis sativa* produce fibre which goes by the name of hemp; *e.g.* species of Crotalaria, belonging to the Leguminosæ, give Siam and Bombay hemp, while Manila hemp is derived from a species of Musa (banana).

Ordinary hemp is an annual herbaceous plant growing from 5 to 6 ft. high or more under favourable soil conditions. The stems are stiff and erect, and bear leaves which are divided into five or more long, narrow, lanceolate leaflets serrated at the edges. It is a diœcious species, *i.e.* the male and female flowers are separate, and produced upon different individual plants. The male plant has a much-branched panicle with large numbers of small male flowers, each with five sepals and five stamens. The female flowers borne upon the female plants are also simple in structure, consisting of a cuplike perianth surrounding a one-celled ovary on which are two long threadlike stigmas; they are produced in smaller numbers, and are more or less hidden among the leaves or bracts of the inflorescences. The ripe ovary or fruit is generally termed the hemp 'seed'; within it is a single true oily seed. Hemp fibre is obtained from the bast of the stem, as in the case of flax, but it is

stronger than and not so fine as that of the latter plant.

The crop can only be grown with success in warm, sheltered districts; the soil most suited to it is a deep, rich alluvial loam containing a fair amount of humus and not too much clay. Newly broken up pasture land and warped areas in the estuaries of rivers yield good returns of hemp. The land should be deeply ploughed in autumn and again in spring, after which it should be well harrowed and rolled in order to produce a fine seedbed. A good dressing of farmyard dung is necessary, put on either in the fresh long state in autumn, or in a well-rotted condition in spring; the addition of 2 or 3 cwt. of salt or kainit is found beneficial. The soil cannot well be in too high a condition, and there is no fear of 'lodging' of the crop. Hemp may be grown several years in succession or in the ordinary rotation. It succeeds well after clover, beans, or roots fed off.

As the young plants are very sensitive to frost, sowing must be postponed in the British Isles and northern Europe to the beginning or the middle of May. Good seed is essential for the best results, and must be raised specially for the purpose and not saved from a crop of hemp grown for fibre, as in the latter case it is immature and only suitable for oil extraction or poultry food. The best seeds are bright, plump, and well-filled, dark brownish-grey; those of greenish-grey hue are unripe, and poor in germinating capacity. Samples of dull appearance, with split 'shells', are usually old and unsatisfactory. Good seed is tasteless, with a greenish-yellow interior; a bitter flavour indicates heating after harvest or in the store.

Where seed for sowing purposes is the product aimed at, the crop should be grown in drills 36 to 40 in. apart, the seedlings being left about 20 in. asunder in the rows. As about 40 per cent of the plants coming up will be males, which can be pulled up after fertilizing the female flowers, the female plants left after this is done have more than a square yard each in which they can develop fully. These must be allowed to continue their growth up to September or the beginning of October, so as to thoroughly ripen their 'seeds' before being harvested. The plants are cut as soon as the husks round the upper 'seeds' are yellow and dried, after which the crop may be thrashed. The 'seed' obtained is then exposed to the air in thin layers in a dry place. Seed plants may also be grown among potatoes or other crops.

Generally, hemp is grown either for the fibre alone or for fibre and seed. In the former case the sowing is carried out as described below, and both the male and female plants are pulled up and harvested together about the time of flowering of the male, which occurs usually in the early part of August. The fibre obtained from the stems at this period is thin and fine, somewhat light in colour, and adapted for the manufacture of the finer kinds of canvas.

When the crop is cultivated for fibre and seed, the sowing takes place in May in drills 16 to 18 in. apart, the amount of seed required being about 2 or 2½ bus. per acre; where a fine fibre is wanted the plants should stand closer together, and 3 bus. of seed is not too much to use.

The young plants soon make their appearance; when about 3 or 4 in. high, they must be thinned or pulled out by hand. The most forward strong-growing specimens are removed, as these are usually males; the rest are left 8 to 12 in. asunder in the row. Growth is so rapid that weeds are smothered by the crop, and hoeing is not necessary except in the early stages. The male and female plants are harvested at different times, the former being pulled up after their pollen has been shed and the upper part of the stems has begun to assume a yellow tint. If left longer, they ripen off and become woody, and the quality of their fibre is greatly reduced. Care is needed in removing them, as their stems must not be broken or bent, and the female plants which are left must not be trampled or broken down.

The pulled plants are put together into small bundles or 'gleans', and tied round the upper part. Later in the day, after drying, the soil is shaken off or knocked out of the root end of the 'gleans' and the latter put up into stooks. In a few days the crop is ready for the retting tank or pond, the bundles being bound round their bases before being sunk.

The female plants are allowed to grow for four or five weeks later, but not until the whole of the 'seed' is ripe. The time for harvesting these is usually early in September, when the husks round the lower 'seeds' or fruits are yellow, and the latter are darkish-grey with firm contents.

The crop is dealt with in a similar manner to that adopted for the male plants, but larger stooks are made, and the upper parts are covered over with undergrowth raked together, or with straw to keep off rain and prevent small birds from taking much of the seed. The seeds ripen in the stook, and when on inspection they are found to fall out of the inflorescences of the dried plants, they are thrashed out on a large cloth spread on the ground in some convenient part of the field.

After separation of the seed the bundles may be retted immediately or put into a stack and left until spring. If the latter plan is adopted the stack should be well made to keep out rain, or the quality of the fibre will be spoilt.

The retting, 'breaking', 'scutching', and 'heckling' processes are practically the same as those employed in the treatment of flax (see art. FLAX), except that some of the machinery used is of heavier character than that needed for the latter crop.

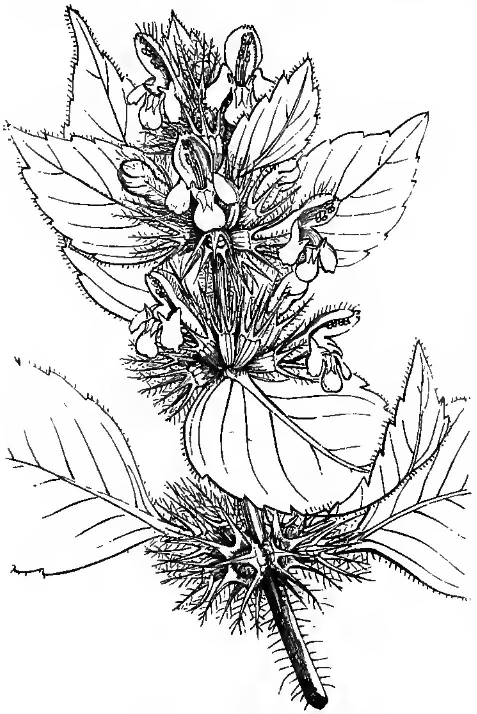
The yield of seed varies from 20 to 25 bus. on an average; of stems 2 to 3 tons are generally grown, from which 6 to 8 cwt. of hemp fibre are obtained. The quality of the fibre depends on its strength, colour, and fineness; the best is usually silvery grey or greenish, that of yellow colour or brownish is inferior. [J. P.]

Hemp Cake.—This cake only occasionally comes into notice in this country. Its composition may be represented by the following analysis:—

Moisture	10·07
Oil	7·14
[1] Albuminous compounds ...	34·81
Digestible fibre, &c.	15·21
Woody fibre	23·79
[2] Mineral matter (ash)	8·98
	100·00
[1] Containing nitrogen	5·57
[2] Including sand	2·54

The oil has a distinctly acid character, and it is questionable whether it is of much value as a feeding oil. The percentage of woody fibre in the cake is high, and samples are generally found to contain an undue proportion of sand. [J. A. V.]

Hemp Nettle (Galeopsis) is the common name for a genus of annual labiate plants frequently occurring as weeds in cultivated fields. The genus is distinguished by the calyx, with five almost equal, spinelike teeth; by the two-lipped corolla, with the upper lip concave, and the lower lip three-lobed, with two teeth on its upper surface; and by the four stamens, of which the outer pair is longer than the inner. The common species are:—



Hemp Nettle (*Galeopsis Tetrahit*)

1. Common Hemp Nettle (*Galeopsis Tetrahit*), a cornfield weed, readily distinguished by the long stiff hairs all over the plant, and by the special swellings on the stems below the opposite leaves. The plant reaches a height of 1 or 2 ft., and at the end of the stem the two-lipped flowers, usually pale-purple but sometimes white, are arranged in dense whorls. A well-marked variety, sometimes regarded as a distinct species, is the large-flowered or variegated Hemp Nettle (*Galeopsis versicolor*), with yellow flowers, having a blotch of purple on the lower lip of the corolla.

2. Red Hemp Nettle (*Galeopsis Ladanum*), has soft downy hairs, and no swellings on the stem. The height rarely exceeds 9 in., and the flowers are rose-coloured, with white spots on the lower lip of the corolla. [A. N. M'A.]

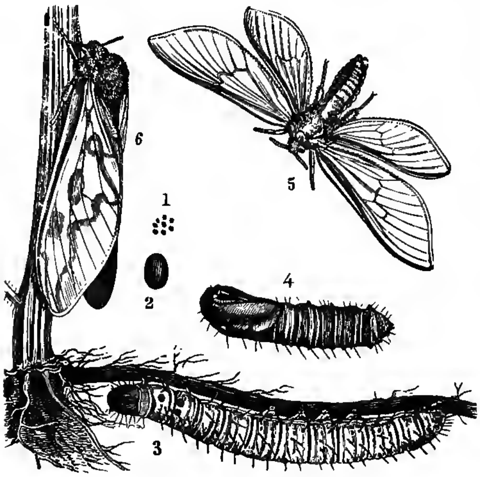
Hen.—This term is applied to female fowls after the 31st of December of the year in which they are hatched. For instance, a bird hatched in April is a pullet until December 31st, and on January 1st of the next year she is regarded as a hen. As a rule, however, for practical purposes the term should not be applied to a bird till after it has passed through one complete laying season. [E. B.]

Henbane (*Hyoscyamus niger*) is a poisonous annual dicotyledonous plant belonging to the same nat. ord. as the potato, namely Solanaceæ. It is found wild on sandy soils, chiefly in the neighbourhood of villages and old castles where the plant was formerly in cultivation. A marked feature is the covering of sticky hairs, which emit a nauseous characteristic smell. The stem is 1 or 2 ft. high, and bears large lobed leaves, the uppermost of which clasp the stem. The bell-shaped flowers are large, over 1 in. in diameter, and have a unique colour, dull-yellow like sulphur, with a network of purple veins; they form as it were a one-sided spike (*scorpioid cyme* or *cincinnus*) at the end of the stem. The fruit (*pyxis*) is also very characteristic, since the dry seedcase opens transversely by a lid like a tankard to allow the small kidney-shaped seeds to escape; the calyx enlarges with the fruit and encloses it (*persistent calyx*). An extract of henbane leaves is used medicinally to alleviate pain and procure sleep. The active principle is a non-volatile alkaloid called *hyoscyamine*, distributed through every part of the plant. No quadruped will partake of this plant to any dangerous extent. Human beings, however, have been poisoned by eating the fleshy roots of the plant. [A. N. M'A.]

Hepatitis, Inflammation of the Liver.—The restraints of domestication and the rich feeding intended to produce muscular power are causes of derangements of the liver, and hepatitis occurs in horses and in dogs, and sometimes in cattle and sheep when put up to fatten and given no exercise. Parasitism is, however, a more frequent source of hepatic trouble in ruminants, a familiar example being that of the liver fluke. Acute hepatitis in the horse may lead to lameness of the off fore limb. Pressure behind the ribs on the right side may show tenderness. Loss of appetite, clammy mouth, depression of spirit, discoloration of the membranes, and general dullness are the chief symptoms, which are only less marked in the chronic form. The latter is met with in stabled horses long accustomed to stimulating food, and given dry, and in the close atmosphere of large studs. The presence of tubercles in cattle and pigs often account for inflamed areas in the liver, and symptoms indistinguishable from those arising out of chills or other causes. *Treatment* is directed

to reduction of the volume of blood in the organ, and repeated small doses of saline medicines are best calculated to effect this purpose. Horses are given 1 or 2 oz. of sulphate of magnesia, with ½ to 1 dr. of powdered nux vomica, twice daily, or the treatment may be commenced with an aloetic ball. A return to grass and a natural life often restores the patient when no actual degeneration of structure has taken place. The same kind of treatment applies to cattle, and the effects may be judged by the changed fæces, which no longer pass in small and hard portions, covered with a glaze and unnaturally pale from absence of biliary matter, or emitting air bubbles when deposited. The urine ceases to show bile staining, and is not high coloured, as may be the case during the attack. Dogs profit by a blue pill with compound rhubarb. Hepatitis in pigs is nearly always due to tuberculosis or parasitism, and they are particularly bad subjects for medical treatment. [H. L.]

Hepialus humuli (the Otter, Large Swift, or Ghost Moth) lays its eggs at the roots



Hepialus humuli (Otter or Ghost Moth)

1, 2, Eggs natural size and magnified; 3, caterpillar; 4, chrysalis; 5, male moth; 6, female.

of nettles, burdock, bryony, and also of the hop plant, and the large cream-coloured caterpillars sometimes do considerable harm in hop gardens, more especially on the Continent, by attacking the roots during the autumn. At the end of April or in May, they spin a very large cylindrical cell amongst the roots, and change inside to a bright rust-coloured chrysalis (fig. 4). From these the moths emerge in June, leaving the horny case sticking half out of the earth.

The sexes differ very considerably in colour, the males being of a fine satiny-white above (fig. 5), but entirely brown beneath; the female (fig. 6) has the upper wings of an ochreous tint, veined and spotted with tawny; the lower wings and under side are entirely brown; they rest with their wings drooping.

As the males flit at twilight over churchyards, appearing and disappearing as their white or dusky sides fall upon the sight, they startle the superstitious, and, from this circumstance, have been termed ghost moths.

H. lupulinus (the Small or Garden Swift) attacks in a similar manner the roots of bush and ground fruit plants and of various vegetable garden crops. [J. C.] [C. W.]

Heracleum, a genus of the order Umbelliferæ, comprising about fifty species of biennial or perennial herbaceous plants, mostly natives of temperate Europe and Asia, nearly half of them being Indian. The cow parsnip of our moist woods and meadows, *H. Sphondylium*, is typical of them; it has stout fistular stems, large pinnate leaves with broad sheathing petioles, and large compound flattened umbels of white flowers. The giant cow parsnip, *H. giganteum*, from the Caucasus, is now wild in this country, and in moist ground it grows to a height of 12 ft., with enormous pinnatifid leaves, and an umbellate head of flowers which has been compared to a cart wheel. It is a grand plant for the wild garden or wherever bold effects are wanted. It seeds freely, and the seedlings flower in their second year and then perish. See also HOGWEED. [W. W.]

Herbaceous Plants.—The three groups into which plants are roughly separated according to their stem characters are trees, shrubs, and herbs or herbaceous plants. But it is often difficult to decide to which of these groups a plant belongs; for example, a rhododendron may be a tree or a shrub according to the conditions under which it has developed, and a Dianthus may be either a shrub or a herb for the same reason. Some authorities limit the term herbaceous to plants with annual stems and perennial roots, but this would remove a host of plants with non-woody stems into the shrub group. Roughly, all plants are herbaceous which do not form distinctly woody stems, and this would include in the group such plants as Aubrietia, Androsace, Campanula, Dianthus, Iberis, Phlox, all bulbous and tuberous plants with annual stems, and of course all annuals. [W. W.]

Herbarium, a collection of dried plants, systematically arranged, formerly styled a *Hortus Siccus*. Whilst it is easier to recognize plants when they are alive than when they are dried and mounted, the difficulty of keeping many of them in a living state makes it necessary to preserve the essential parts of them in such a way as to render them useful for future reference. A herbarium specimen, to be perfect, should have root, stem, leaves, flowers, and fruit. These should be selected from a plant of average dimensions, and each part should represent not an exceptional but the prevalent form. If the plant or parts are too large to form a specimen of convenient size (15 in. long and 10 in. wide), it should either be reduced to that length by folding, or those portions should be taken that display the peculiar aspect of the plant. These should be dried by laying them flat between several sheets of bibulous paper, and subjected to sufficient pressure to prevent undue shrinking without crushing. The papers will require to be changed often enough to prevent their

getting mouldy. When dry, the specimens may be laid in separate folded sheets of paper, with a label giving particulars of locality, date of collecting, &c. If convenient, however, the dried specimens may be at once mounted on sheets of stiff paper, either by gumming them on to the paper, or securing them to it by means of straps of gummed paper fixed here and there. The arrangement of the specimens in drawers or cabinets should be with a view to ease of access for purposes of comparison, &c. It is best to place the species of each genus together, and the genera in their natural orders.

There are two national collections of dried or herbarium specimens in England, one in the Natural History Museum, South Kensington, the other at Kew. The Kew Herbarium is said to be the largest, the most accurately named, and the most conveniently arranged in the world. It occupies an enormous building, and a large staff of botanists is permanently employed in its keep. Large parcels of specimens are continually arriving from various parts of the world, and these are sorted, named, mounted, and laid into their respective positions, so that by consulting the collections it is possible to see without difficulty not only how many species of a genus are represented or known, but also what parts of the world each specimen was collected in, and to what extent variation has occurred. There are herbarium specimens which have been dried several centuries and are still in perfect condition. Some of the oldest of these are in the Natural History Museum at South Kensington. Systematic botany would be practically impossible were it not for the preservation of the specimens of plants in herbaria. [W. W.]

Herbs and Herb Industry.—Some thirty years ago, a large variety of herbs were extensively grown in market gardens between fruit trees and on odd plots of ground not available for other crops. Unremunerative prices have, however, made it impossible to pursue their cultivation to any appreciable extent, and what was once known as the 'Mitcham Herb Industry' is fast becoming a thing of the past. Thus the large areas once devoted to the cultivation of herbs, also lavender, roses, and many other plants, are either built upon or have given place to more profitable crops. The larger proportion of the home industry has migrated to the Continent, more particularly to Germany, from whence manufacturers receive their supplies principally in the form of crude essences. There is still a somewhat limited demand for green herbs such as Thyme, Marjoram, Basil, &c.; when bunched up, they occupy but little room, and are sent to market along with other produce, being in some seasons very remunerative. There is practically no market for dried herbs, these being supplied by Continental firms at a price too low to encourage home competition.

The following are among the principal herbs still met with in nurseries, market and private gardens, a brief account being given of their economic value and cultivation:—

ANGELICA (*A. Archangelica*), a biennial herb, native of England and the north of Europe, and considered of great medicinal value, at one time being often used in confectionery. In cultivation it succeeds best in cool situations, and is often seen to perfection on the banks of streams, provided that the soil is sufficiently fertile. Seed is sown in autumn or spring in moist soil. When sown in autumn the seedlings should be transplanted in the following March, about 2 ft. apart each way. The stalks will be fit for use in May or June of the following year; even if not required, the stems should be cut down before there are any signs of seeding, as, when this is done, the plants will live for three years.

BALM (*Melissa officinalis*), a hardy perennial, native of the south of Europe, and often used in making balm tea or drink for sick persons. Its young shoots are sometimes used in salads and for other culinary purposes. Propagation is performed by dividing the roots in autumn or spring, and planting 1 ft. apart in any ordinary garden soil.

BASIL (Sweet) (*Ocimum Basilicum*).—Basil is a native of the East Indies, and is usually propagated by sowing seeds in gentle heat during spring. When sufficiently large to handle, they are pricked out into boxes of soil and finally hardened off, after which plant out on a warm border composed of light rich soil, and keep shaded and watered until established.

BORAGE (*Borago officinalis*).—This herb is used in the preparation of claret cup and other similar drinks. The usual method of propagation is by divisions or cuttings, also from seed, which is sown from March to May in ordinary garden soil, the seedlings being thinned out to 15 in. apart. For spring use, seedlings are raised in heat and transplanted into frames, the lights being removed on mild days to admit abundance of air.

BURNET (*Poterium Sanguisorba*) is a hardy perennial, native of Britain. The young and tender leaves have a flavour and odour similar to that of cucumbers, and are sometimes used in soups. Propagation is effected by division, or by sowing seed in spring and autumn on comparatively light soil in drills 8 in. apart. When 3 in. high the plants should be thinned out to 6 in. apart.

CAMOMILE or CHAMOMILE (*Anthemis nobilis*), a perennial herbaceous plant, held in high repute as a medicinal agent. It thrives on any rich, light, and comparatively dry soil, and is readily propagated by division of the roots; the small rooted portions are planted 2 ft. apart each way, the space between the rows being intercropped with some quick-growing species until the Camomile plants are thoroughly established. As the bloom expands they are picked off by women or children, who usually receive 1*d.* to 1½*d.* per lb. for gathering them. The flowers are placed in shady but airy places to dry, before being offered for sale.

CARAWAY (*Carum Carvi*), a naturalized biennial, the seed of which is largely used in confectionery, also for flavouring and perfumery. An oil for medicinal purposes as a carminative is also obtained from the seed. Plants are readily raised from seeds sown in spring on ordinary soil, provided it is not too damp in winter. The seedlings should be thinned out to 8 in. apart,

when the seeds will ripen in the autumn of the following year.

Chervil (*Anthriscus Cerefolium*), a hardy annual, grown for its leaves, which are used in salads and for flavouring soups. To ensure a constant supply of the leaves, seeds are sown monthly from February to September, taking care to thin out the seedlings to 8 in. apart.

Chives or Cives (*Allium Schœnoprasum*), a hardy native perennial, readily increased by division of the root, and succeeding in any ordinary soil. Used in soups and salads in preference to onions, on account of its mild flavour.

Coriander (*Coriandrum sativum*), a hardy annual, the young leaves of which are sometimes used in soups and salads, and for purposes of flavouring. The seeds are largely used in confectionery. Plants are easily raised by sowing seed in warm loamy soil, and where the leaves are in demand, successive monthly sowings should be made.

Dill (*Anethum graveolens*), a biennial plant, native of Spain and Portugal. The leaves are used in soups, sauces, and various condiments. Seed is sown in spring, and the seedlings thinned out to 8 in. apart.

Fennel (*Fœniculum vulgare*) is a perennial aromatic plant, indigenous or naturalized in this country. The leaves are used for garnishing and in the preparation of fish sauces, while the seeds are sometimes employed in confectionery and for flavouring liquors. Propagation may be effected by seeds or offsets. The former are sown in warm soil during March or April either in drills or broadcast, and the seedlings thinned out to 1 ft. apart. If propagated by root division, this is best performed in March.

Horehound (*Marrubium vulgare*) is a perennial, native of Britain, and is regarded as a remedy for colds and coughs. Propagation is effected by sowing from February to April, or by cuttings planted in a shady border at a distance of 18 in. apart. Planting should proceed in April, and the ground be kept free from weeds and thoroughly clean, when the plant will last for several years.

Hyssop (*Hyssopus officinalis*), an aromatic evergreen herb, native of southern Europe. The flowers and tops of the plant are sometimes steeped in water in the form of an infusion, which is employed in medicinal practice. It succeeds best in warm situations and in a dry light soil. Seeds may be sown in April, or propagation may be effected by means of cuttings or divisions of the roots. Plants raised by the former method should be transplanted when sufficiently high, and will need a thorough watering until firmly established.

Liquorice (*Glycyrrhiza glabra*) is not nearly so extensively grown as in former years. As with many other herbs, the expense incurred in its cultivation is such as to render it anything but remunerative. Well trenched, sandy, and heavily manured ground is essential for its growth. Propagation is effected by cutting off portions of the creeping rootstock from 4 to 6 in. in length, containing at least two buds. It should be ready for planting in February or early March in rows 3 ft. apart, and 18 in. from each other in the row, with a subsequent covering of earth to a depth of 2 or 3 in. The plants should be intercropped until the intervening space is taken up by the plants themselves. When the stems have matured they are cut off level with the soil, and the ground between the rows is forked over to keep it free from weeds, and manure given if required. The roots will be ready for lifting three years after planting, which operation is best performed in the winter by taking out a deep trench close to the first row, when by fastening a rope round the crown of the roots they can be pulled out, and stored in sand, like carrots or beets, until sold.

Marigold (*Calendula officinalis*), a hardy annual, native to southern Europe, the flowers of which are sometimes used in soups. There are single and double flowered varieties, and apart from their culinary value they form a pleasing border of mixed plants. Propagation is easily effected by means of seeds, which should be sown in a frame in April. A moderately rich light soil is most useful for this purpose, and when the plants are sufficiently large they should be put out in beds, with a space of 9 in. between them.

Marjoram (*Origanum majoram*).—This plant is cultivated for the sake of its leaves, which are of high value as an aromatic for all culinary and general purposes, and may be propagated by seed sown in March in a gentle hotbed. It succeeds best in a dry soil. An equally successful method of increasing the plant is by means of divisions, which should be taken in March or April and planted in a frame. When in flower the tops should be cut and dried in the shade for winter and spring use.

Parsley (*Carum Petroselinum*) is a fairly remunerative crop where good retentive and fertile soil can be secured for its cultivation. Successional sowings of seed are made in shallow drills from March to August. If sown too thick, the seedlings should be thinned to the required distance. Parsley rarely withstands transplanting, and the frosts of autumn tend to destroy the foliage, therefore it may be necessary to afford some means of protection; but only in exceptional cases is the grower repaid for this additional labour.

Pennyroyal (*Mentha Pulegium*) is a species of mint, and is readily propagated by division of the roots in September, March, or April. It succeeds best in a moist loamy soil, and planting should be effected in rows at a distance of 1 ft. apart and 6 in. from plant to plant.

Peppermint (see 'Spearmint').

Purslane (*Portulaca oleracea*) is an annual, and a native of South America. The leaves are possessed of cooling properties and are often used in salads. Purslane requires a light rich soil and a warm situation. It should be sown in shallow drills 9 in. apart. Planting in the open should be delayed until April or even May, as the young plants are easily affected by frost.

Rosemary (*Rosmarinus officinalis*), a hardy evergreen undershrub, and considered efficacious in the form of a decoction in relieving beadaches. It thrives best in a light dry soil and a warm situation. Propagation can be effected by cut-

tings taken in April or May. These should be planted 3 to 4 in. deep in a rather shady situation, and should be left undisturbed until September, when the roots will have attained a fair size. They can then be transplanted at that time or in the following spring, the distance between the plants being 2 ft.

Rue (*Ruta graveolens*) is an evergreen undershrub. From a medicinal point of view the leaves are of especial value, being considered as a stimulant and an antispasmodic. Rue will flourish in almost any kind of soil, and can be raised by seeds planted in March or April. Cuttings and slips are also employed, and should be inserted in a warm shady border until root action is thoroughly established, after which they may be planted out in rows 18 in. apart and 8 in. from plant to plant. An occasional trimming is necessary, and every third year a portion of the plantation should be cut down in order to encourage young shoots.

Sage (*Salvia officinalis*).—Both red- and green-leaved varieties of this plant are cultivated. Propagation is effected by division, the divided portions being inserted in rows from 1 to 2 ft. apart each way. In good holding soil, growth is rapid, and in the autumn the stems are cut off, tied in bunches, and marketed.

Savory (*Satureia hortensis*, Summer Savory; *Satureia montana*, Winter Savory) is employed as an aromatic flavouring for soups and salads, and is also used in various culinary preparations. It is generally raised from seed, which should be planted in a warm border and well watered at the time of planting. When in flower, a quantity should be pulled up, dried, and stored for winter use.

Southernwood (*Artemisia Abrotanum*) is grown for its medicinal properties, which are somewhat similar to those of wormwood. It is easily raised from seeds and cuttings, and any garden soil is favourable for its cultivation. The fragrance of its finely divided leaves forms another reason for its cultivation.

Spearmint (*Mentha viridis*) and Peppermint (*Mentha piperita*) are propagated by pulling up young rooted shoots from established plants during spring and planting about 1 ft. apart. At the end of the two following seasons they are ploughed in, and afterwards kept free of weeds by hoeing. In August the green shoots are cut for distilling. Where permanent beds are to be formed, damp soil should be selected, and if space is available, another crop may be planted between the rows during the first year; later, the roots and underground stems are too numerous to admit of further intercropping.

Tansy (*Tanacetum vulgare*) is a hardy perennial, and is cultivated for the sake of its aromatic leaves, which are used in colouring and flavouring puddings. It is generally propagated by divisions, which should be planted in February or March about 1 ft. apart.

Tarragon (*Artemisia Dracunculus*).—A perennial plant, native of Siberia. The leaves are valued for their seasoning properties in salads and vinegar, &c. Dry warm situations are most favourable to this plant, and they should be protected to a small extent through the winter, to guard against the effects of frost. It is propagated by means of divisions taken in March or April. These should be planted in deeply dug ground about 8 in. apart.

Thyme (*Thymus vulgaris* and *T. Serpyllum vulgaris*).—The common green- and golden-leaved varieties of thyme are still grown. The former is raised from seed sown in May, and the latter by division of the roots in May. The golden-leaved variety is considered the best to cultivate, on account of its free habit of growth. The divided roots are frequently planted between fruit trees, or as edgings to borders, where a firm soil, essential to their growth, is secured. The young leafy tops or sprigs are bunched similarly to other herbs.

Wormwood (*Artemisia Absinthium*) is a hardy perennial, possessed of an aromatic and intensely bitter flavour, and is largely employed in medicine as a tonic or stomachic. It grows well in any kind of soil, but will thrive best in a poor and rather dry soil, which is somewhat warm.

[J. C. N.]

Herd.—Like the word 'flock', the term 'herd' denotes a collection of certain animals of the same kind. Though the two words are often interchangeable, 'herd' is nearly always applied to cattle or pigs or goats; 'flock' to sheep, ducks, geese, &c.

Herd Book, a publication annually issued by a society of breeders of a particular kind of cattle. The object and aims of the herd book are similar to those of the flock book. See Flock Book.

Herdwick Sheep.—The Herdwick is the mountain sheep of Cumberland and the adjacent Fell district of Westmorland, 'herdwick' being an old name in this district for a pasture for sheep. There is no hardier sheep in existence, and its sweet, fine-grained, lean flesh is unsurpassed in quality; hence prime Herdwick mutton is in great request in the local markets of the north-west of England, and is also well known and highly appreciated in the London markets. It can maintain itself through the long Cumberland winter on the scanty herbage of the fells alone, so long as the surface of the ground is not covered with deep or frozen snow. At such times it requires a little hay to carry it along; and a characteristic winter fell scene of the district is that of the shepherd with his staff and dog, plodding along the hillside through the snow with a bundle of hay on his back for the sheep.

The striking unlikeness of the Herdwick to any other Scotch or English mountain breed of sheep has awakened much curiosity as to its origin; and concerning it there is much obscurity; but tradition has it, that about the time of the Spanish Armada a Spanish vessel was stranded on the west coast of Cumberland, and forty small sheep managed to escape from it to the sandy coast of Drigg, and were claimed by the lord of the manor. From these the present Herdwicks are said to have descended.

The point that strikes strangers most when seeing a Herdwick for the first time is its thick-set sturdy appearance and carriage—a short, thick head; short, strong, thick legs standing

well apart; a thick round body well let down and not too long, and covered with a heavy fleece of coarse wool, all tend to give this general impression.

The breed points of the Herdwick may be described as follows:—

Fleece and Colour.—The lambs when born should have black heads and legs, without spots of any kind except a little white on the ear tips and some white hairs round the feet, which spread as the sheep gets older, producing the 'hoar-frosted' ears, and grey bands round the feet. The lamb's body is frequently patched and spotted with black, but later on the fleece does not distinctly show the spots, though it has a somewhat grey appearance, generally quite sooty on the rump and round the ruffle of the neck. The black of the face gradually changes to a steel-grey, toning to nearly white towards the nostrils. The fleece consists of strong wool, almost hairy on the shoulder top, the body being well covered everywhere—under the belly and down to the knees and hocks; the tail is broad and bushy; the neck wool forms quite a ruffle, and the forehead carries a good topknot. According to age they clip from 4 to 5½ lb. of wool, which is largely used for carpetmaking.

The Head.—The head is broad and short, nostrils wide, and jaws deep, the nose Roman—in striking contrast to the head of the Cheviot or Scots Blackface in general appearance. It is carried well up on a strong neck. The eye is prominent and lively, amounting to defiance in the ram. The male alone carries horns, which should spring well from the back of the head, and be well curled and smooth. The ears are fine and erect, and always on the move. There is a general alertness of appearance about the Herdwick which is quite striking.

Body and Legs.—The body is cylindrical and placed well inside the legs; this accounts for the legs being wide apart, and for the body being well let down towards the ground. The body should be rather short, being ribbed nearly to the hooks. The chest is broad and deep, and arms and thighs thick and muscular. The legs are strong, the knees being very stout and feet large. The rough and bristly covering of the hind legs still more increases their sturdy appearance.

The lambing period in the Fell districts of Cumberland is the month of May, which is as early as the hill pastures will allow; for a good bite of spring grass wherewith to keep up the ewe's supply of milk is not available till well into this month. The ewe flock is brought near home for convenience of lambing, and for a short time after lambing they get the shelter and better herbage of the lower-lying pasturage. Herdwick ewes seldom bring more than a single lamb each, and that is as much, as a rule, as they can do justice to under ordinary conditions. The ewes are usually fattened after the fourth lambing and sold to the butcher; but frequently for the fourth lambing they are crossed with a Border Leicester or Wensleydale ram to produce much larger and earlier maturing sheep, to be either sold as fat lambs or sent to the lower-lying tillage farms for fattening on turnips. Pure Herdwick wether lambs used to be allowed to grow and fatten on their native fells until 3 years old, and then be 'drawn' for the market through the summer as fast as they fattened, so that practically three-year-old wether and ewe mutton were the only forms in which Herdwick mutton came into the market. If well fattened, these sheep will dress from 12 to 18 lb. a quarter. The modern taste is more in favour of younger mutton, and an eighteen-months Herdwick wether is now considered more toothsome than a three-year-old. But it cannot grow and fatten fast enough for this on the fells; this quicker feeding must therefore be undertaken on the more lowland farms. Before bringing Herdwicks into comparatively small fields it is essential to examine the fences, for they are the most difficult of all sheep to keep within bounds, and will creep through any gap or jump any low wall. But what may be done by good though careful feeding (for they dare not at first be pushed in the feeding) may be gathered from the following results obtained by the writer in the season of 1906–7.

About the middle of October some Herdwick wether lambs were bought at one of the autumn lamb sales at 11*s.* each. They were run on good land old pasture through the winter, being supplied with a rack of hay from December onwards, and having a few swede tops thrown out to them as long as these were available. In January a small quantity of cut swedes was given them in troughs daily, and about the middle of March a little oats and linseed cake were added to their diet. The corn and cake were very gradually increased, but never together exceeded ⅓ lb. per head per day. The sheep were clipped in June, the fleeces averaging 4 lb. 2 oz. each, which realized 8*d.* a lb. They were sold fat at the local auction mart (Penrith) early in July at 35*s.* 6*d.* each, and must therefore have dressed from 13 to 14 lb. per quarter. It was estimated that the cost of 'keep' per head for the whole period was as nearly as possible 12*s.*, so that the case stands thus financially: Selling price of carcass and wool, 38*s.* 3*d.*; cost price and value of food, 23*s.*; profit 15*s.* 3*d.*, which will compare favourably with any other form of sheep-feeding for mutton.

The custom of drafting four-shear Herdwick ewes for sale, for crossing for the fourth and last lambing with a Border Leicester ram, has already been referred to. The narrow head, early maturing, big size, and superior wool of the Border Leicester specially adapt it for mating with these small slower-growing sheep. The cross lambs have not such large heads as to make lambing with small dams difficult, while the over fatness of the Border Leicester is counter-controlled by the lean character of the Herdwick. The cross-bred lambs mature quickly for the lamb market if born early in spring, or make excellent hoggs (tegs or hoggets) for fattening on turnips for the mutton market if born later; while the ewe lambs, if kept for breeding, become the best cross-bred ewes in existence for partly arable farms in exposed situations. They may not be quite as good milkers or quite as prolific yeaners as the ordinary 'cross-bred ewe' (Scots Blackfaced–Border

Photo. G. H. Parsons.

HERDWICK RAM—"KING MOOR 3RD"

1ST PRIZE WINNER, ROYAL COUNTIES SHOW, 1907

Photo. C. B. Woodley.

HERDWICK EWE

WINNER OF THREE 1ST PRIZES, FELL DALES SHOW, 1909

Leicester), but for hardiness, size, quick feeding, and quality of mutton and wool they would be difficult to beat by any other first-cross sheep. These first-cross ewes are often again put to a Border Leicester tup, but may with as much advantage be mated with an Oxford Down, Wensleydale, or other large, quickly maturing sheep.

The pure Herdwick may be seen at its best at any of the agricultural shows in the Fell districts of Cumberland, but perhaps nowhere to such perfection as at the Eskdale 'Fell-dale' Show held at the 'Woolpack' at Boot, via Ravenglass, in West Cumberland, in September. Here the winners at all the earlier shows meet for competition, and a great trade is done in selling and letting Herdwick rams for the breeding season. [W. T. L.]

Heredity.—In all ordinary cases a living creature has its individual beginning as a fertilized egg cell, in which all the heritable qualities or characters are implicitly contained. The female parent's contributions, including some of those of her ancestry, are in the egg cell, which is often microscopic; the male parent's contributions, including some of those of his ancestry, are in the still more minute sperm cell. When the sperm cell or spermatozoon unites in an intimate and orderly way with the egg cell or ovum, the two sets of parental contributions unite to form a new individuality—a creature like to, and yet different from its parents. We do not know how the numerous characters that make up an inheritance can be carried in minute germ cells, but we know that it is so. It may be remembered that even the minute germ cells have room for great molecular complexity, and that the characters somehow borne in them are, so to speak, initiatives, which will develop in interaction with an appropriate environment and with one another. In any case, the physical basis of inheritance is in the sperm cell and egg cell produced by the parents. Heredity is simply a convenient term to denote the reproductive or genetic relationship between successive generations, and inheritance is all that an organism is or has to start with in virtue of this hereditary relation. Of course, the fertilized egg cell will not develop (or give expression to the inheritance) except in suitable surroundings, for the hereditary 'nature' requires an appropriate 'nurture'.

Many animals of a simple sort, such as sponges, polyps, and worms, can be multiplied by being cut into pieces, just as potatoes and many other plants are multiplied. Many animals multiply asexually by giving off large buds or portions of themselves, just as many plants do. These portions tend to grow into exact replicas of the parent, and the reason for like producing like is no puzzle in these cases. The separated portion is a representative sample of the parent organism, and in appropriate conditions it naturally grows into a practical facsimile of the parent. It *reproduces* the parent. But why should like beget like in the great majority of cases, where the mode of multiplication is not by large separated portions, but by egg cells and sperm cells? The answer to this question is found in the theory of germinal continuity. Let us state its purport. There is a sense, as Galton says, in which the child is as old as the parent, for when the parent's body is developing from the fertilized ovum, a residue of unaltered germinal material is kept apart to form the future reproductive cells, one of which may become the starting-point of a child. In many cases, scattered through the animal kingdom, from worms to fishes, the beginning of the lineage of germ cells is demonstrable in very early stages before the division of labour implied in building up the body has more than begun. Let us suppose that the fertilized ovum has certain qualities, a, b, c . . . x, y, z; it divides and redivides, and a body is built up; the cells of this body exhibit division of labour and the structural side of this which we call differentiation; they lose their likeness to the ovum and to the first results of the cleavage of the ovum. In some of the body cells, the qualities a, b find predominant expression, in others the qualities y, z, and so on. But if, meanwhile, there be certain germ cells which do not differentiate, which retain the qualities a, b, c . . . x, y, z unaltered, these will be in a position by and by to develop into an organism like that which bears them. Similar material to start with, similar conditions in which to develop,—*therefore*, like tends to beget like. To use Weismann's words: 'In development a part of the germ plasm (*i.e.* the essential germinal material), contained in the parent egg cell, is not used up in the construction of the body of the offspring, but is reserved unchanged for the formation of the germ cells of the following generation'. Thus the parent is rather the trustee of the germ plasm than the producer of the child. In a new sense, the child is 'a chip of the old block'.

There are many reasons for believing that the material particles corresponding to the various hereditary characters have their vehicle in the nuclei of the germ cells, but it is perhaps too soon to call this or that part of the germinal matter the exclusive bearer of the hereditary characters. Professor E. B. Wilson states the general opinion of experts somewhat as follows: As the ovum is much the larger of the two germ cells, it is believed to furnish the initial capital —including, it may be, a legacy of purely nutritive yolk — for the early development of the embryo. From both parents alike comes the inherited organization which has its seat (according to most biologists) in the readily stainable (chromatin) bodies within the nuclei. From the father, in the spermatozoon, there comes a little body called the centrosome, which seems to organize the machinery of division by which the egg splits up, and distributes the dual inheritance equally between the daughter cells.

Without going further into these microscopic matters, we may briefly state four conclusions, which are suggested by a study of the physical basis of inheritance. (1) In ordinary sexual reproduction the inheritance is very precisely dual or biparental. Recent discoveries have shown that the paternal and maternal contributions which come together in fertilization (see FERTILIZATION) are, for several divisions at least, exactly divided among the daughter cells, thus

confirming a prophecy which Huxley made in 1878: 'It is conceivable, and indeed probable, that every part of the adult contains molecules derived both from the male and from the female parent; and that, regarded as a mass of molecules, the entire organism may be compared to a web of which the warp is derived from the female and the woof from the male'. (2) Inheritance, though always dual, may be as truly multiple, for the heritable material of each parent is also dual, being derived from the grandparents, and so on backwards. (3) In regard to the dual nature of the inheritance, we can see that the ovum and the spermatozoon have equal numbers of chromosomes (or readily stainable nuclear bodies), and it is well-known that this number is half that which occurs in the ordinary body cells of the species in question. For each species there is a definite number of these chromosomes in all the cells of the body, but the ripe germ cells have always half the normal number. In the union of the equal number of chromosomes from the father and from the mother, we have an index to the dual nature of the inheritance. But this does not imply by any means that the dual contributions will find equal expression in the full-grown offspring. Breeders have often occasion to remark in the offspring what looks like an entire absence of the characteristics of one of the parents. The foal may seem to take entirely after the sire, as if the maternal inheritance counted for nothing. We have to distinguish between the inheritance and the expression of it in development, and that this is no verbal distinction is evident from the numerous cases in which a characteristic of one parent skips a generation and reappears in the grandchildren. It was not absent from the inheritance though it was unexpressed or undeveloped. (4) Curious experiments, such as making an egg cell develop without being fertilized by a sperm cell, or such as rearing an embryo from a non-nucleated quarter of an egg cell duly fertilized, seem to show conclusively that each germ cell bears a complete equipment of the hereditary qualities. It is exceedingly important to get a firm grasp of the fact that the individual organism — be it horse or hen—has all its inheritance, so to speak, in duplicate. For any particular character there is a hereditary contribution from the mother and another from the father. These may be practically the same, so that the offspring is pure-bred, in respect of that particular character at least; or they may be markedly dissimilar, so that the offspring is cross-bred in respect of that quality.

The largest fact of heredity is that like tends to beget like. We have seen the reason for this. When the body of the parent is a-making, a lineage of germ cells is started, and some of the unspecialized descendants of these develop into offspring, which are on the whole like the parent because they are made of the same stuff. What are called 'true' twins, which develop from one ovum, are usually almost facsimiles of one another, and similarly offspring sometimes appear to be almost facsimiles of their parents. That this is not usual is obvious, for against the tendency to repetition or persistence we have to set the fact of deviation or change. Against the fact of hereditary resemblance we have to set the fact of variability. Like *tends* to beget like. Variability is perhaps a primary quality of living creatures; in any case there are many reasons why offspring should differ from their parents. They arise from germ cells which have been sojourning in the parent's body, exposed to a changeful food stream, and often to a changeful bodily and external environment. They arise from germ cells which pass through a remarkable process of maturation in which there are opportunities for new permutations and combinations of the hereditary items. They arise from the union of two sets of hereditary contributions which have often had very different histories. It is also possible that variations may crop up for unknown internal reasons. It is perhaps legitimate to suppose that the germ plasm slowly changes as it grows from generation to generation — because it is its nature so to do. Sometimes, moreover, the offspring differ from their parents not in variations of internal origin, but by modifications of external origin, *e.g.* lack of food. And the offspring may differ from its parents through the apparent absence of certain characters which are really there all the time, the apparent absence being due to the lack of the appropriate environmental stimulus. This kind of deviation may, of course, be obliterated next generation, when the full environment allows the latent character to re-express itself. In short, for many reasons, we cannot say 'like begets like', but 'like *tends* to beget like'. Against the general hereditary resemblance or persistence, we have to place the fact of variability or divergence.

Although prediction as to the result of any individual pairing is apt to be falsified, there are some well-known alternatives of expectation, and in some cases the average result may be predicted with certainty. (1) When similar forms are bred together for several generations, a certain uniformity of type is likely to result. If by selection the most similar are mated together, while the least similar are persistently removed from the stock, and if there is also some measure of inbreeding, then there is likely to be more or less secure uniformity of type. These 'pure-bred' organisms produce others like themselves, and we suppose this to mean that the hereditary items in the ovum have not only their counterpart but their equivalent among the hereditary items in the spermatozoon. This, then, is one of the modes of inheritance—that the offspring closely resemble the parents and one another. The variability is restricted within a small range.

But there are other more or less well-defined modes of hereditary resemblance which occur very frequently. (2) The offspring may be a combination of the paternal and maternal characteristics in such a way that the result may be described as an intimate *blend.* In a cross between the long-eared lop rabbit and a short-eared breed, Castle found that forms with ears of intermediate length are produced, and that these intermediates breed true. (3) The off-

spring may show what may be called a coarse-grained or non-blended combination of the paternal and maternal characteristics, the former showing in one part of the body, the latter in another part, as when a light-coloured horse and a dark-coloured mare have a piebald foal, or when a sheepdog has an eye like its father on one side and an eye like its mother on the other side. This is often described as *particulate* inheritance. (4) It often happens that the offspring seems to take wholly after one of its parents, and extreme forms of this are spoken of as *exclusive* inheritance. Although the inheritance is dual, it seems as if only one set of the heritable characters found expression—sometimes those of the mother, sometimes those of the father. The more pure-bred parent is the more likely to be 'prepotent' in the inheritance.

(5) In typical cases of Mendelian inheritance, which will be discussed at length in the article MENDELISM, we have to do with the pairing of two pure-bred types which differ from one another in respect of one or more unit characters, which may be obvious qualities, such as colour and stature, or more subtle qualities, such as the loaf-producing 'strength' of the wheat, its susceptibility or immunity in respect to rust, the broodiness or non-broodiness of poultry, the horned or hornless state of the head in cattle. The result of the crossing is that the progeny resemble one parent only in respect to the contrasted characters which will not blend. The offspring of the grey and the white mice are all grey; the offspring of the tall and the dwarf peas are all tall; and so on. It is usual to speak of the character that persists and is expressed as the *dominant* character, while that which remains unexpressed or latent is called *recessive.* But when these 'hybrids' are inbred, the next generation shows a reappearance of the original parental types both dominant and recessive—both breeding true—and a number of forms—usually *like* pure dominants—which, when inbred, again produce pure dominants, pure recessives, and 'impure' dominants. In typical cases where attention is paid to one pair of contrasted characters, the proportions of the 'hybrids' always approximate to the formula 1 pure dominant : 2 impure dominants : 1 pure recessive. When attention is paid to two pairs of contrasted characters, for instance when a tall yellow-seeded pea is crossed with a dwarf green-seeded one, the offspring are tall yellows, and when these are self-fertilized (which is equivalent to inbreeding) out of 16 offspring there are 9 yellow talls, 3 green talls, 3 yellow dwarfs, and 1 dwarf green. When a rabbit of the wild grey colour is crossed with an albino the offspring are all grey, and these if bred together give in certain cases 9 greys, 3 blacks, and 4 albinos, which is a slight modification of the ordinary 9 : 3 : 3 : 1 ratio due to the impossibility of distinguishing by external appearance between two different kinds of albinos. (6) Another mode of inheritance (which may in many cases turn out to be a particular case of the Mendelian mode) is seen when the offspring exhibits features which were not expressed in its immediate ancestry, but were characteristic of its more remote ancestry, as when crossing different races of pigeons, which have been breeding true, results in the return of the ancestral rock-dove type (see REVERSION).

(7) Lastly, just as we began by noting that the offspring of carefully pure-bred types might be almost replicas of the parents, so we must notice the opposite extreme, where the offspring represent something quite new—a novel position of organic equilibrium—a 'freak', or 'sport', or 'mutation', or 'discontinuous variation'. That these new departures have sometimes formed the beginning of a new domesticated breed or cultivated variety is well known; and it is possible that species in nature may sometimes have arisen in a similar way.

Important conclusions in regard to heredity —notably those summed up in 'Mendel's Law' —have been reached by definite experiment, but there are other conclusions which have been reached by applying statistical methods to the observed facts. Thus there is Galton's 'Law of Filial Regression', which expresses the tendency of offspring to approximate to the general mean or average of the stock. This is most readily understood by taking an actual case (from Pearson's Grammar of Science, 1900, p. 454): 'Fathers of a given height have not sons all of a given height, but an array of sons of a mean height different from that of the father and nearer to the mean height of sons in general. Thus take fathers of stature 72 in., the mean height of their sons is 70·8 in., or we have a regression towards the mean of the general population. On the other hand, fathers with a mean height of 66 in. give a group of sons of mean height 68·3 in., or they have progressed towards the mean of the general population of sons. The father with a great excess of the character contributes sons with an excess, but a less excess of it; the father with a great defect of the character contributes sons with a defect, but less defect of it. The general result is a sensible stability of type and variation from generation to generation.' It must be noted that this idea of filial regression—which is suggestive in connection with the establishment of a stock of any kind—has nothing to do with reversion or with degeneration, it works upwards as well as downwards, it means a tendency towards the average. Filial regression is the relapse or the advance of offspring from the parental type towards mediocrity, and it depends on the fact that an organism inherits from its ancestors as well as from its parents. There are many considerations which lead us to regard an individual inheritance as a mosaic made up of contributions from a complex of ancestors, which when traced back, say to a tenth generation, correspond to an average sample of the stock in question. The difficulty is to correlate this statistical conclusion with experimental (*e.g.* Mendelian) conclusions, which are certainly true in particular sets of cases. From data collected in regard to stature and other qualities in man and as to coat colour in Basset hounds, Galton reached the important generalization which he calls the 'Law of Ancestral Inheritance'. The law is as follows:

'The two parents between them contribute *on the average* one-half of each inherited faculty, each of them contributing one-quarter of it. The four grandparents contribute between them one-quarter, or each of them one-sixteenth; and so on, the sum of the series $\frac{1}{2}+\frac{1}{4}+\frac{1}{8}+\frac{1}{16}+\ldots$, being equal to 1, as it should be. It is a property of this infinite series that each term is equal to the sum of all those that follow: thus $\frac{1}{2}=\frac{1}{4}+\frac{1}{8}+\frac{1}{16}+\ldots$; $\frac{1}{4}=\frac{1}{8}+\frac{1}{16}+\ldots$, and so on. The prepotencies or sub-potencies of particular ancestors, in any given pedigree, are eliminated by a law that deals only with *average* contributions, and the varying prepotencies of sex in respect to different qualities are also presumably eliminated.' Thus an inheritance is not merely dual, but through the parents it is multiple, and the *average* contributions made by grandparents, great-grandparents, &c., are definite, and diminish in a precise ratio according to the remoteness of the ancestors. It is, of course, quite legitimate to accept the general idea of the Law of Ancestral Inheritance without accepting the fixity of the fractions—that the parents contribute $\frac{1}{2}$, the four grandparents $\frac{1}{4}$, the great-grandparents $\frac{1}{8}$, and so on.

The study of heredity may be pursued in at least three distinct ways: (*a*) There is the microscopic study of the germ cells, which has shown us, for instance, the exact equivalence in number of nuclear bodies in the sperm cell and egg cell, an equivalence doubtless representative of the general equivalence of the paternal and the maternal contributions. (*b*) There is experimental breeding, which has already yielded us the fundamentally important generalizations of Mendel and his successors. (*c*) There is the application of statistical methods to collections of measurements bearing on inheritance, which has already yielded us the fundamentally important generalization known as Galton's Law of Ancestral Inheritance. Great results have rewarded the pioneer investigators along each of these three lines, but there can be no doubt that these are only a promise of much that is still discoverable and to be discovered.

Brief reference must now be made to some of the much-disputed questions concerning heredity and inheritance. There is the long-drawn-out controversy as to the possible transmission of 'acquired characters' or somatic modifications. In this connection it is essential to understand the precise point at issue. Members of the same species often differ from one another, and these differences can be measured and registered under the title of 'observed differences'. So many of these differences depend on age and sex, and these can be readily recognized and allowed for. Others depend on peculiarities of 'nurture' in the wide sense, that is they are the direct results of changes in surrounding influences or in function. Such changes in plant or animal are impressed from without, they are 'exogenous' in origin, they are not inborn but acquired, and they are technically called 'modifications' or 'acquired characters'. They may be defined as structural changes in the body of an individual organism, directly induced by changes in function or in environment, which transcend the limit of organic elasticity and persist after the inducing conditions have ceased to operate. Thus fattening and sunburning are modifications, though the predisposition to them may be inborn; the formation of a callosity as the result of pressure and the reduction in a muscle by prolonged disuse are modifications, though it does not of course follow that callosities and reduced muscles may not come about in a quite different way, namely by a germinal variation. For when we subtract from the total of 'observed differences' between members of the same species all that can be described as modifications, we find a large remainder which we must define off as inborn or germinal variations. We cannot causally relate them to any peculiarities in the organism's habits or surroundings, they are often distinct at birth or hinted at before birth, they are rarely alike even among forms whose conditions of life seem absolutely uniform. They are endogenous, not exogenous in origin; they are results of changes in the germinal material; they are born, not made; and they are more or less transmissible, though they are not by any means always transmitted. They form—at least some of them form—the raw material of organic evolution, whereas modifications, as defined, are probably not of direct importance in evolution since we have no secure evidence that they are ever transmitted as such or in any representative degree. There is no doubt that modifications are very common, that they are of much individual importance, that they may have an indirect influence through the body on the offspring (especially in the case of mammalian mothers), that they may have an indirect importance in evolution in several ways, but the precise point at issue is this: Does a structural change in a part of the body, induced by use or disuse, or by change in surroundings and nurture generally, ever influence the germ plasm in the reproductive organs in such a specific or representative way that the offspring will thereby exhibit the same modification that the parent acquired, or even a tendency towards it? The writer does not know of any clear case which would at present warrant the assertion that a somatic modification is sometimes transmitted from parent to offspring.

As a particular case of the transmissibility of acquired characters, we may take the very important and difficult question of the transmissibility of acquired disease. When the question is carefully considered, it seems possible to distinguish between (1) abnormal or deranged processes which have their roots in germinal peculiarities or defects (*variations*), which express themselves in the body to a greater or less degree according to the conditions of nurture; and (2) abnormal or deranged processes which have been directly induced in the body by acquired *modifications*—*i.e.* as the results of unnatural surroundings or habits, including the intrusion of parasites. There is very little evidence to suggest that this second kind of disease is heritable as such, though the indirect effects may without doubt influence the offspring. When we go further and come to understand that pre-natal infection is not inheritance, that inheritance of

Photo. G. H. Parsons.

HEREFORD BULL—"CAMERONIAN"

1ST AND CHAMPION, R.A.S.E. SHOW, 1906

Photo. G. H. Parsons.

HEREFORD HEIFER—"SHOTOVER"

CHAMPION AT THE R.A.S.E. SHOW, 1904

a predisposition to a disease is not inheritance of the disease, that the general weakening of the offspring through disease in the parent is a very different matter from the transmission of a specific disease, we are almost irresistibly led to the conclusion that in the sense in which the word 'inherited' is used in biology, there are no inherited diseases.

Among the other difficult questions, we may mention: (1) Is it the case that particular features characteristic of a remote ancestor may be dormant for a long series of generations — unexpressed in development — and then suddenly reassert themselves? (See REVERSION.) (2) Is there scientific warrant for believing in the influence of a previous sire on offspring subsequently borne by the same female to a different sire? (See TELEGONY.) (3) Is there any evidence that the vivid sense impressions of a pregnant mother may so affect the unborn offspring that structural changes result which have some correspondence with the maternal experience? Of much greater importance, however, are enquiries such as these: In what cases are the facts of inheritance clearly Mendelian, and how do these cases differ from others which seem as clearly non-Mendelian? What adjustment of statement will establish harmony between Mendel's Law and Galton's Law? What is the nature of the character which we call 'maleness' or 'femaleness', and is there any law discoverable which will formulate its distribution in the progeny of a pair? See BREEDING, LAWS OF; MENDELISM; REVERSION; VARIATION. [J. A. T.]

Hereford Cattle.—It may truly be said of most if not of all the breeds of cattle we have in the United Kingdom that their history is lost in antiquity. The Hereford is no exception to this general statement. Mr. Thomas Duckham, M.P., who was for some years editor of the Hereford Herd Book, when lecturing before the students of the Royal Agricultural College, Cirencester, in 1863, said: 'As regards the origin of the breed, little is known or can be gleaned previous to the eighteenth century'. William Marshall, an agricultural writer of considerable repute, in his Rural Economy of the West of England, published in 1796, expressed the opinion that 'the Hereford, Devon, Gloucester, and North Wales cattle all sprung from the same stock'. Whatever their origin, it is clear that the county of Hereford, from the nature of its soil and climate, is admirably adapted for the raising of a superior type of cattle. An old writer on the history of that county truly said: 'The climate is most healthful and temperate, and the soil so fertile for corn and cattle that no place in England yieldeth more or better conditioned'. A visit to Hereford fair in October would, in these days, confirm the opinion expressed by the earliest writers, of the good qualities of this most useful breed. At this fair, one instinctively notices the uniformity and general good quality of these cattle. Careful breeding and judicious selection have been the means by which the numerous herds of these handsome animals have been brought to the high position they now occupy in the agricultural world. It is to the credit of the tenant farmers of the county of Hereford that by far the larger proportion of the herds with any pretensions to purity are in their hands, and not, as in the case of some other breeds of cattle, owned chiefly by noblemen.

The Hereford Herd Book was commenced by Mr. T. C. Eyton of Eyton Hall, Salop, in 1846. The copyright was afterwards sold to the Hereford Herd Book Society. Youatt, in his book on cattle, published in 1835, speaks of the Herefords as being easily recognized by their white faces, throat, and bellies, and dark-red bodies. Some have conjectured that the white face was originally obtained from crossing with the smoky-white faces of the red cattle of Montgomery. This white face has appropriately been termed in America their 'tribal badge'. With most of our breeds of cattle there has been some outstanding notable improver in years gone by. Charles Colling was the pioneer breeder of Shorthorns; Bakewell of the Longhorns; Quartly of the Devons; and so with the Herefords. Though others may have assisted in the general improvement of the breed, yet to Benjamin Tomkins and his descendants must be given the chief place in bringing this breed so prominently before the public. Tomkins was born at Canon Pryon in 1745, and although his family for generations had been breeders of cattle, it was this member of the family who attained especial notoriety as a breeder of Herefords. After his death in 1815 a portion of the herd was sold, when twenty-eight head averaged 150 guineas each. Since those days, well-bred Herefords for stock purposes have commanded good prices, though none have reached the sensational figures made by individual Shorthorns. Yet such prices as 150 to 200 guineas have not been unusual. In the palmy days of beef production, when large-sized and more aged oxen were in demand, Christmas bullocks frequently made as much as 50 guineas, but in these days of early maturity and smaller joints a fair average will be from £20 to £25.

Hereford cattle are equal, if not superior, to the best Shorthorns as beef producers, though not so good in their milking qualities as the best strains of dairy Shorthorns. That they are admirable for beef is unquestionable, and the great cattle breeders in America class them as 'a premier breed of beefmakers'. Uniformity of type is characteristic of this class of cattle, and their placid gentle countenances indicate aptitude to fatten either in the stall or on pasture. It is also a breed remarkable for early maturity. It has been said that 'the secret of successful cattle feeding lies in an ability to ripen prime beef at an early age—baby beef'. In this respect the Hereford is unrivalled. Some butchers have the impression that they are apt to be 'creamy', that is put too much fat on the outside; but this fault is probably due to injudicious feeding, or want of judgment in breeding. What are spoken of by dealers and farmers as 'Welsh Herefords' are often slow feeders, and do not attain to the same weight as those bred true to type; and the result is often an animal resembling the Hereford, but not retaining its aptitude to fatten. These inferior animals, though having the same colours and generally resembling the well-bred

variety, are apt to create a wrong impression of the breed.

The colours of the Hereford are uniform, correct markings being: the major part of the body a rich red; the face, throat, chest or brisket, the lower part of the body, legs, and brush of the tail a clear white. The hair wavy, soft, and moderately long. They carry flesh most abundantly on the parts from which the best meat is taken. The chest is wide and deep, the dewlap being prominent. It is an animal which 'faces you well'. The back straight and broad; loin and hind quarters good, enabling the butcher readily to supply customers with the favourite 'porterhouse steak'. The horns of the oxen have usually a graceful curve, with a white and waxy appearance. In the case of the female they frequently turn upwards. The muzzle is flesh-coloured, a dark one being objectionable as much so as with the Shorthorns. In America a polled Hereford has been evolved and the type fixed. In other respects it has the same characteristic colours and points. It is said of the Herefords that they are in this country more free from tuberculosis than other breeds. This is probably owing to the open life they lead, most of the calves running out at grass with their dams. The legs of a well-bred bullock are short, compared with the massive frame which they carry. The fore quarters are broad. This is essential for all beef-producing animals. A narrow fore quarter betokens diminished vitality, and with weakened vitality or constitution all chance of making the animal profitable is lost. This point can hardly be too much emphasized. One inferior animal purchased with ten or twelve others will often reduce the profit of the whole lot, when fattened, to vanishing point. Breeders, for generations, have striven to develop in Hereford cattle the greatest weight in the most valuable parts, with the minimum of second-rate meat and offal. The conformation of the thigh in the Hereford is one which meets the requirements of the butcher, there being abundance of meat in the twist or inner thigh. As a grazing animal it is probably pre-eminent, not only in this country, but also in America, the Argentine, and the Australian Commonwealth. Being of a quiet disposition and docile, it fattens well on ordinary herbage without artificial food. This fact is exemplified in such counties as Bedford, Leicester, and Northampton, where farmers find the Herefords to be most satisfactory. Hardly any gentleman's park is considered suitably stocked unless it has a herd of these handsome creatures beautifying the landscape. In old times they were commonly used for ploughing and other draught purposes, and they can still be seen carting hay and corn, as well as doing ploughing and other agricultural work, on the picturesque estate of Earl Bathurst at Cirencester. In Australia, where prolonged droughts occur periodically, Herefords are found to retain their condition longer than other breeds, and it is a well-known fact that they can travel long journeys, spoken of as 'overlanding' in Australia, and arrive at their destination in better order than other classes of cattle.

It is to their credit that at our annual Christmas fat-stock shows in London, Birmingham, or elsewhere, Herefords are always in the front rank, and have carried off more prizes than any others. Pure-bred herds of Herefords have been established in various parts of the United Kingdom, and are by no means exclusively confined to the county from which they derive their distinctive name. Prince Albert, the late Queen Victoria's Royal Consort, laid the foundation of the herd at the Flemish Farm, Windsor, in 1855, and many prizes were obtained by the Queen, and more recently by her son, His Majesty King Edward VII. The splendid bull Fire King, illustrating the breed for this article, was bred by His Majesty at the Royal Farm, Windsor, and was awarded first prize, as well as being the champion in the Aged Bull class, at Park Royal in 1905. He was born February 20, 1901, and was by Earlsfield (19,387), dam Firefly by Lollipop (16,814). He had the unique position of being for the third time champion in his class. The Hereford heifer Lemster Plum, the photograph of which has been selected from among females to illustrate the breed in this Cyclopedia, was bred by Mr. A. E. Hughes, Wintercott, Leominster, Hereford. She was first and champion female at the Lincoln Royal Show in 1907, as well as gaining first honours at Hereford, Shrewsbury, Aberystwyth, and Newport. The herd which she so well represents was founded in 1845 by the late Mr. T. Edwards, from whom it passed at his death to Mrs. Edwards, and was transferred in 1881 to the present proprietor. It has had a long and honourable record, winning a vast number of prizes. Other well-known breeders, all of whom have distinguished themselves in the prize ring, are Messrs. William Tudge, Summer Court, Kingston; A. P. Turner, The Leen, Pembridge; G. D. Faber, M.P., Rush Court, Wallingford; T. R. Thompson, Erior Delyn, Penarth; T. S. Minton, Montford, Shrewsbury, and many others equally familiar to agriculturists. Foreign buyers who come to this country to purchase sires for the improvement of their stock naturally visit the herds which have attained prominence, and they must frequently have a difficulty in deciding from which to select.

Herefords were first introduced into Scotland by Mr. Lumsden in Aberdeenshire more than forty years ago. They readily adapted themselves to the change of soil and climate, and there have been many instances where the cross between the Hereford bull and the Scotch Shorthorn cow, or the Hereford bull and the Aberdeen-Angus polled cow, produced remarkably good animals for beefmaking purposes. In these cases a large percentage of the progeny exhibited the characteristic white face of the Hereford. In Ireland the manager of the Irish estates of the Duke of Bedford established a herd more than a century ago in County Westmeath, and from that time the Herefords have been well represented in that part of the kingdom.

Mr. Stone, of Guelph, Ontario, was probably the first to import this breed into Canada, and for some time the increase of Herefords

Photo. F. Babbage.

HEREFORD BULL—"FIRE KING"

1ST AND CHAMPION, PARK ROYAL, 1905

HEREFORD HEIFER—"LEMSTER PLUM"

1ST AND CHAMPION FEMALE AT ROYAL LINCOLN SHOW, 1907

shipped to the Dominion was very marked. From 1880 to 1883 fully one-half of the breeding cattle taken there were Herefords. It is, however, to our Australian colonies and to North and South America that we must look for the wonderful increase in numbers of this favourite beef producer. The Messrs. John and David M'Connell of Cressbrook and Durundur, Queensland, who for many years were famous in that colony for their cattle, state that the first imports of the Herefords were to Tasmania in 1825, and from that colony spread rapidly into New South Wales, Queensland, and Victoria. In 1885 the Messrs. M'Connell, at the Brisbane annual show, obtained with the Hereford bull Prince Leopold the special prize given by the president of the association for the best bull of any breed. Messrs. M'Connell, like many other squatters in Queensland and New South Wales, have largely adopted the Hereford as being the best for attaining early maturity on grass only. Mr. Angus of Collingrove Station, Queensland, emphasizes this point, as well as the fact that Herefords have the character for being capital workers, and able to travel long distances in dry weather. Large numbers of cattle have to journey from 500 to 800 miles to the slaughter-houses, so that this quality in the Hereford is one of considerable importance. A Queensland Hereford Herd Book Society has been established, which no doubt will tend to keep the breed up to its high standard of quality. Several Hereford herds have been settled in New Zealand, one of the first being that of Mr. E. Maclean of Butley Manor, Auckland, who imported bulls from the Royal Flemish Farm, Windsor. It is generally admitted in our Australian colonies that the pure Hereford bull used on herds of no particular breed produces a cross which is readily fattened. It is no doubt on this account that many dairy farmers in districts like Somersetshire frequently cross their Shorthorn milking cows with a Hereford bull.

In the early part of the 19th century various attempts were made to introduce the Hereford into the United States and to Canada, with more or less success. Gradually their good qualities became acknowledged and appreciated and more were imported, and they have rapidly increased, until now it may be safely said that their number in proportion to other breeds is quite equal to that which obtains in this country. No great effort has been made, either here or in other parts of the world, to produce a distinctly milking strain of Hereford. Indeed if this were done they would undoubtedly lose their character for beef. Instances are on record where milk has been a primary consideration, notably in the herd of Mr. J. G. Cooke, Moreton House, Hereford, whose cow Patience made a remarkable record. The usual practice in this country and in America and our colonies is for the cow and calf to run together at grass for about six months, after which the young steer or heifer is steadily kept on until it has attained an age of two to two-and-a-half years, when it is generally of suitable weight and quality for the butcher. The prepotency of the Hereford is such that in any country a pure bull of that breed is sure to stamp the offspring with his own good qualities. What the Americans term the 'rustling' properties of the bull are interestingly illustrated in the experience of a South Dakota ranchman, who turned on to his ranch three bulls—a Hereford, a Shorthorn, and an Aberdeen-Angus. In the subsequent 'round up' they found seventy-five white-faced, three blacks, and forty Shorthorn calves. The Shorthorn bull was dead, the Aberdeen-Angus was in fair condition, and the Hereford was fat enough to kill for beef. Some idea of the extent of the American ranches may be gathered from the language of a writer on the subject when he says, 'that nothing equals a bunch of Herefords on grass; they are attractive in pairs, pretty in dozens, fine in scores, grand in hundreds, but sublime in thousands'.

The American Hereford Association was established in 1881, and its headquarters are now at Chicago. Representatives from all the States attend its meetings; its growth and prosperity have been extraordinary; its roll of members numbers more than fifteen hundred. It has published twenty volumes, in which are registered a quarter of a million pure-bred animals. Under the auspices of this association, in 1901 there was gathered together in Kansas City the largest collection of any one breed the world has ever seen. At an auction sale in 1902 at Indianapolis, the three-year-old Hereford bull Crusader made the remarkable price of 10,000 dollars. Perfection was sold the same year at Chicago for 9000 dollars. It is evident that the American farmer is impressed with the superiority of this class of cattle for supplying the rapidly growing population of his country with beef of the best quality.

The Argentine Republic is also rapidly developing its vast resources, and some of the estancias are of enormous size, and carry large quantities of cattle. They have land enough, and of sufficiently good quality, to breed a vast number of cattle. It is said that the Hereford, on account of its hardiness, is more adapted than any other class of cattle for that large area of land lying between Rio Negro and Tierra del Fuego. In Rio Grande, which has some three millions of cattle, largely composed of what are there termed 'creoles', they are now 'grading up' these cross-bred animals with Hereford bulls. Messrs. Olivera & Sons, Floresta, Buenos Ayres, have imported largely for this purpose. Buyers from South America purchased freely at our annual sale of Herefords in 1908. Out of 255 which were shipped in the twelve months ending December 31, 1907, 250 went to South America; and our English society has presented, as testimony of the appreciation of South American patronage, two fifty-guinea cups with gold medals, to be competed for at South American shows. Even if the supplies of beef from North America to this country should ere long fall short of our requirements, there is but little doubt that the necessary shipments will be readily obtained from the Argentine Republic.

[E. Bl.]

Heritors, a Scots law term which originally was synonymous with landowners, as op-

posed, for example, to mere liferenters or to tenants. In the modern use of the term it denotes the parties who are liable for the building or maintenance of churches or manses, and the provision of churchyards and glebes in a parish. Meetings of heritors are called on the requisition of their clerk, or of any heritor or heritors possessed of lands yielding one-fourth part of the total real or valued rental of the parish, addressed to the minister of the parish, or, if he consider such meeting advisable, at the instance of the minister himself. Intimation of the meeting is given from the pulpit immediately after divine service in the forenoon, and circular letters sent to all heritors at least twenty-one free days before the meeting. If, however, the number of heritors exceeds forty, advertisement in a local paper once during each of two successive weeks between the intimation from the pulpit and the day of the meeting may be substituted for the circular letter. A meeting of the heritors may also be convened by the presbytery, in which case intimation from the pulpit alone is probably sufficient notice. Each meeting elects its own chairman, who has a deliberative, but not a casting vote. The voting is *per capita*, each vote being of equal value irrespective of the value of the heritor's holding; absent heritors are entitled to vote by proxy. If the meeting be regularly called, one heritor present forms a quorum. A resolution regularly carried is binding on the general body of heritors, who have no redress unless the action complained of is clearly illegal or fraudulent, grossly reckless, or wilfully negligent. [D. B.]

Hermaphroditism in Animals, the occurrence of male and female reproductive organs in the same animal. This may be normal or abnormal; it may be thoroughgoing or only partial. In many of the lower animals, such as snail, leech, and earthworm, it is normal; but in spite of the hermaphroditism, in the cases mentioned and in most others there is cross-fertilization. In a few cases, such as the liver fluke and some tapeworms, there is self-fertilization, or autogamy; that is to say, the eggs of a given animal are fertilized by the sperms of the same animal. This is prevented in most cases of normal hermaphroditism by a want of time-keeping between the male and female organs, the testes being functional at one time and the ovaries at another. When the animal produces spermatozoa first, the condition is called protandry; thus the hag (*Myxine glutinosa*) is believed to be a protandrous hermaphrodite. When the animal produces eggs first, the condition is called protogyny; thus many of the Ascidians or sea-squirts, which are all hermaphrodite, are protogynous.

Turning to occasional or abnormal hermaphroditism, we find illustrations of this at almost all levels in the animal kingdom, though the bisexuality has not always the same degree of thoroughness. Thus there are hermaphrodite butterflies and moths, hermaphrodite cod and herring, hermaphrodite frogs and toads, birds and mammals. Sometimes there is a testis on one side and an ovary on the other; oftener the reproductive organ on one side or on both sides is partly ovarian and partly testicular. In these casual hermaphrodites it is very rare to find both organs in a functional state; usually only one is functional, often neither is functional.

What is sometimes called superficial hermaphroditism is illustrated in abnormal forms which have only one kind of essential organ, but have in the reproductive ducts or in external parts some of the features of both sexes. It is so difficult to draw the line that it is much clearer to keep the term 'hermaphroditism' for the occurrence of ovaries and testes to some extent at least in the same organism. Some incompleteness in the normal unisexual differentiation may remove the usual limits to the appearance of this or that secondary sexual character, or may allow of a somewhat mixed condition in the development of the internal ducts or of the external genitalia. 'From the fact', Professor O. Hertwig remarks, 'that the external sexual organs are originally of uniform structure in the two sexes, we can understand the fact that, in a disturbance of the normal development, forms arise in which it is extremely difficult to decide whether we have to deal with male or female external organs. These cases, in earlier times, were falsely interpreted as hermaphroditism.' They are rather due to arrest of development, *e.g.* when the testes do not descend into the scrotum or when the penis is very imperfect; or they are due to exaggerations of development, *e.g.* when the female has a simulation of a penis. As arrests and exaggerations occur in all parts of the body, it is not *necessary* to suppose that the suppression or simulation of a penis implies anything imperfect in the testis or the ovary respectively.

A reference must be made to the sex of twin calves. As Spiegelberg and others have shown, the twins may be both female and both normal, or male and female and both normal, or both males, in which case one always exhibits the peculiar abnormality that gains it the name of 'freemartin'. The internal organs are male, but the external accessory organs are female, and there are also rudimentary female ducts (uterus and vagina). A further study of 'freemartins' is much to be desired.

As to the relation of hermaphroditism to the unisexual condition, we cannot do more than speculate. Gegenbaur expressed the opinion of most authorities when he said: 'The hermaphrodite stage is the lower, and the condition of distinct sexes has been derived from it'. On the other hand, it has been maintained that hermaphroditism may have arisen secondarily from the unisexual condition. Perhaps both views are tenable, for there may be a primary and a secondary hermaphroditism. [J. A. T.]

Hermaphroditism in Plants, *i.e.* the development of both (male and female) sexual elements in the same organism, is of very wide-spread occurrence in the group of the flowering plants (Angiosperms), where the unisexual condition is much rarer. In the Angiosperms the pollen developed in the pollen sacs of the stamens produces the male sexual elements, which are carried by means of the pollen tube to the female sexual cells situated in the ovules of the ovary.

As a rule, the flowers of the Angiosperms contain both stamens and ovaries, and it is to such flowers that the term *hermaphrodite* is applied. Flowers are described as *unisexual* when they contain either stamens or ovaries, but not both simultaneously; such unisexual flowers sometimes contain rudiments of the other sexual organ, thus showing their derivation from ancestors with hermaphrodite flowers (see below). When the flowers are unisexual, the male and female ones are sometimes developed on distinct plants (willow, herb mercury, &c.), but more commonly the two kinds of flowers are present on the same plant (hazel, beech, spurge, &c.), and in this case the plant as a whole may be said to be hermaphrodite. In the Gymnosperms the unisexual condition is the rule, the male organs (here united to form the so-called cones) being found either on the same or on different plants to those bearing the female cones. In this group the unisexual condition is probably the primitive one, while in the Angiosperms hermaphroditism is the primary condition, and most (if not all) cases of unisexuality are secondary. In spite of the fact that hermaphroditism is the rule in Angiosperms, the ovules of a certain flower are often not fertilized by the pollen of that flower; in other words, self-pollination (which is not as advantageous as cross-pollination) is not the rule. In some cases, indeed, the pollen altogether fails to germinate on the stigma of the same flower (as in rye, and certain Cruciferæ), and in certain orchids pollen from the same flower even has a poisonous action, leading to the withering of the latter. Very commonly, again, pollen from another flower is more efficacious than the pollen of the same flower, and so effects fertilization more readily. Self-pollination is further largely prevented by a phenomenon known as *dichogamy*, *i.e.* the ripening of the pollen and stigma at different times in a hermaphrodite flower. Most commonly it is the pollen that is shed before the stigmas of the same flower are in a receptive condition (so-called *protandry*, *e.g.* Umbelliferæ), while the reverse state of affairs (so-called *protogyny*, *e.g.* many grasses, horse-chestnut, &c.) is much rarer. In such cases the flower passes through a male and female stage, and where there is no overlapping of the two the flower is physiologically unisexual, first male and then female, or vice versa; as a rule, however, there is a more or less considerable period of overlapping of the male and female stages, during which self-pollination may be possible. In a considerable number of cases, indeed, provision is made for self-pollination should cross-pollination fail, and in some plants (particularly in those having cleistogamous flowers, *e.g.* violet) the former is made a necessity (for further details. see art. on FERTILIZATION IN PLANTS).

Among Cryptogamic plants the term 'hermaphrodite' is used to designate the simultaneous occurrence of antheridia and archegonia on the same plant. Most of the true ferns and a considerable number of mosses and liverworts are hermaphrodite, while the horsetails and club-mosses are unisexual. Among the Thallophyta, where there is a differentiation of sex, hermaphroditism is the commoner condition. [F. E. F.]

Hernia.—This is the term used for escape of the bowel or other organ from its proper enclosure. Surgeons use the word rupture in the case of an organ that is broken or rent, as a ruptured liver. See RUPTURE.

Heron.—The name Heron is usually applied to the members of the genus Ardea of the family Ardeidæ, which comprises in addition the bitterns and the night heron. Half a dozen different species of Heron have from time to time been obtained in various parts of Great Britain, but their visits are in most cases so rare and uncertain that they can scarcely be called British birds. The one species which is generally distributed throughout the British Islands is the Common Heron (*Ardea cinerea*). In the days of falconry its breeding places were strictly protected; and though the protection is now removed, the number of heronries in England does not appear to have diminished, while in Scotland numerous small colonies are scattered over the mainland and islands. The heronries are occupied from February to August, the birds resorting to the same place for many years in succession. They select almost any kind of locality where they are undisturbed—high trees, hills, level ground, sea cliffs, bushes, or reeds. The nest is large, made with sticks and lined with twigs and grass, and in it are laid three or four large eggs. The food consists mainly of eels, flounders, and other coarse fish, which must be set against the depredations which it commits in trout streams. They also feed upon reptiles, worms, insects, crustaceans, &c. When fishing, the Heron stands motionless in shallow water, with its head drawn back, ready to strike with its beak anything edible that may come within reach. See art. GREY HERON. [H. S. R. E.]

Hesperis, a genus of Cruciferæ comprising about twenty species of annual or perennial herbs, natives chiefly of Europe and Northern Asia. They have somewhat the habit of the stock, the best known being the common Rocket (*H. matronalis*), which has become naturalized in various parts of England, where for many years it has been a favourite garden plant on account of the showiness and fragrance of its flowers. Under cultivation it has varied considerably, double-white and double-blue forms being common. They come true from seeds, as do so many other domestic forms of Cruciferous plants. They may also be easily multiplied by division or cuttings. *H. tristis* is the night-scented stock, whose small dull-coloured flowers are so very fragrant at night. [W. W.]

Hessian Fly, a midge common to Europe and North America which is destructive to the cereal crop. See CECIDOMYIA.

Heterodera, a genus of eelworms, or microscopic nematodes, infesting the roots of various plants, and causing galls or swellings. The young worms and the males are of the ordinary eelworm type, but the females are flask-shaped and stationary. *H. Schachtii* infests the roots of beet and also of the hop plant. *H. radicicola*, the 'root-knot eelworm', especially affects tomatoes and cucumbers, but it has been found in a variety of other plants, including cabbage, turnip, clover, and lucerne. Fruit trees also suffer,

especially the peach. Where cucumbers or tomatoes are grown in frames it is possible to treat the soil in such a way as to kill the worm. Carbolic acid at the rate of 33 oz. per 15 cu. ft. has proved effective. In field cultivation judicious rotation must be chiefly relied on; but it should be remembered that composts containing the refuse of diseased crops are especially dangerous, and that the worm may even be carried to new areas in the soil clinging to the horses' hoofs or the boots of labourers. [C. W.]

Heuchera, a genus of Saxifrageæ containing about twenty species of perennial herbs, all natives of North America. Some of them are popular hardy herbaceous plants, *H. sanguinea* being particularly showy. It has a tuft of geranium-like leaves, and elegant racemes of tubular crimson flowers. This has been crossed with several of the less showy but coarser-growing species, the result being a race of easily grown, free-flowering, decorative plants suitable for the herbaceous border. They may be propagated by division or from seeds. [W. W.]

Hibernation. — When the cold weather sets in, many animals pass into a peculiar comatose condition called winter-sleep or hibernation. For weeks or months they remain without feeding or moving, and with a marked reduction in the vigour of the internal activities, such as the beating of the heart. Many cold-blooded animals, such as snails, frogs, snakes, and lizards, illustrate this coma; among warm-blooded animals hibernation is restricted to a relatively small number of mammals. It is a life-saving reaction that has arisen as an adaptation to northern and alpine conditions. In Britain it is exhibited by all the bats, the hedgehog, the shrew, the squirrel (to a slight extent), the dormouse (for six months), and the field vole. The winter-sleep varies greatly in its duration and in its depth, and it is definitely related to the habits of the creature. Thus, those mammals that lay up stores of food or can continue to forage in winter do not hibernate. The physiology of hibernation is still very incomplete, but it may be noted that in hibernating mammals there seems to be a suspension of the normal warm-bloodedness. In the case of the Zizel (*Spermophilus citillus*), Horvath found that the temperature fell to 2° C., the same as that of the room in which the animal was kept. In short, the hibernators become temporarily more or less cold-blooded, taking on the temperature of their surroundings. During the hibernation the fat of the body is slowly consumed, sustaining the essential minimum of animal heat; the heart beats feebly and irregularly; the breathing movements are slow; there is no excretion from the kidneys or very little; the senses are not readily stimulated. The immediate conditions that bring on the hibernating state seem to be the cold and lack of food; the re-awakening is preceded by a marked rise of body temperature which does not appear to be directly associated with any external rise of temperature. [J. A. T.]

Hibernia defoliaria (the Great Winter Moth or Mottled Umber Moth) is one of the group of Geometer moths whose wingless females crawl up the trunks of fruit trees to lay their eggs on the shoots. The male moth measures $1\frac{1}{2}$ in. or more across the extended wings, the fore wings being reddish-brown with two dark transverse bands, the hind wings paler, with a dark spot near the middle. The wingless female has conspicuous paired dark spots along the back. The 'looper' caterpillar is $1\frac{1}{4}$ in. in length when full grown, chestnut-brown above and yellowish below. Its habits, and the measures for prevention and remedy, are the same as in the case of the common Winter Moth (see CHEIMATOBIA BRUMATA). [C. W.]

Hibiscus, a large genus of Malvaceæ including herbs, shrubs, and trees, and distributed chiefly in tropical regions. Some of them, known as Rose Mallows, are natives of North America, and are sufficiently hardy to thrive out-of-doors with us; they are *H. moscheutos*, *H. grandiflorus*, and *H. coccineus*. They require a warm, sunny position, and plenty of moisture at the root. *H. syriacus* is a hardy deciduous shrub which grows well and flowers freely in the warmer parts of the British Islands. There are numerous colour forms of it, from pure white to crimson and almost blue; also double-flowered varieties. *H. rosa sinensis* is the big red-flowered tropical shrub which is grown here and there as a warm conservatory plant. *H. Trionum*, sometimes called *africanus*, is a pretty hardy annual about 2 ft. high, with large flowers coloured yellow and purple. *H. cannabinus*, largely cultivated in India and other tropical countries, is an annual from the stems of which hemp is made. *H. esculentus*, the Okro, is another annual which is largely grown in the Tropics for the sake of its fruits, which are used as an article of food and for thickening soups. [W. W.]

Hickory is the name applied to the genus Hickoria (Sargent, long called Carya), belonging to the Juglandaceæ or Walnut family, and yielding edible nuts resembling walnuts in flavour, but enclosed in husks dividing into four equal valves. As a genus all the Hickories yield a heavy, hard, and tough timber, with whitish-yellow sapwood and brownish heartwood, and are somewhat similar to Ash both in appearance and in technical properties. Hickory is one of the strongest of the American hardwoods, but is not durable when exposed to moisture. It is largely imported into Britain and used for carriage shafts and spokes, axe- and pick-handles, golf-club shafts, fishing rods, &c. The Hickories are all North American trees, some of which attain a height of 60 to 80 ft. or more, and a diameter up to about 2 ft. The bulk of the logs imported into Britain measure about 18 in. in mean diameter. There are eleven or more species of Hickory, the chief of which are: (1) the Whiteheart or Mockernut Hickory (*H. alba*), yielding the common 'hickory-nut', (2) the Small-nut Hickory (*H. microcarpa*), (3) the Big Shell-bark Hickory (*H. sulcata*), (4) the Shell-bark or Shag-bark Hickory (*H. ovata*), and (5) the Pig-nut Hickory (*H. glabra*). All of these North American species yield the Hickory timber of commerce, but that of *H. alba* is what is most largely imported into Britain. Supplies of this fine timber are now beginning

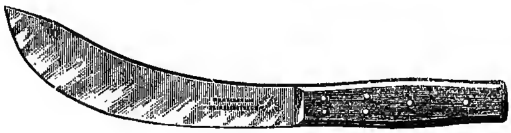
to run short. The *H. alba* and *H. ovata*, indigenous to the northern part of America, grow well in Britain, though sylvicultural experiments have not yet been made to show if their cultivation on any large scale in woodlands may prove profitable. [J. N.]

Hidebound or **Hide Bound.** — Men accustomed to handle and deal in live stock attach much importance, and rightly, to the condition known by the above name. The thriving animal has a layer of fat under the skin, and the latter is easily pinched up by the fingers, giving a soft yielding sensation which implies health and prosperity. The poor starveling or the diseased or worm-ridden animal is hidebound, that is, has his skin tightly adherent to the ribs, and the covering hair or coat imparting a harsh and altogether unthrifty feeling. The hidebound animal will, in any case, take some time before he begins to pay for his keep, although his condition may be due to bad wintering or poor food; but disease is to be suspected, and great caution should be exercised in purchasing such an animal. A hidebound horse is not equal to full work, and a beast will not fatten nor a cow give a fair supply of milk if hidebound. Any debilitating disease, such as tuberculosis, will be liable to cause it. Worm medicines, tonics, and good food are the remedies, unless some specific disease is discoverable. [H. L.]

Hide of Land, *plough-land*, or in Scotland, *ploughgate of land*, is a term used to denote the amount of land which could be ploughed by a single plough in one year. In England this was held by some to be 60 ac., by others 80, and by others 100 ac., and it is probable that there was no fixed standard, but that local usage determined the extent. In Scotland a ploughgate was usually estimated at about 104 ac. Scots, which for practical purposes is equivalent to 130 imperial acres. See OXGANG. [D. B.]

Hides.—Until a few years ago hides were looked upon in this country as a small by-product. This was to a great extent, especially in England, due to the old system of selling the hides while the animals were alive, at so much per hide. In this way, little or no notice was taken of any bad work done by the slaughtermen, or the amount of dung which was attached to the hides. Not many years ago, at the Birkenhead and Deptford Lairages, hides were sold at anything from 15*s.* to 20*s.*, depending on the demand. The butcher took the meat, and the hide merchant got the hide, no attention being paid to the flaying. The American firms were not long in observing that a big loss of money was going on every year, due to bad management and bad workmanship. American butchers were brought over, and they brought with them special knives, which can now be bought at any up-to-date cutler's in this country. The result of the introduction of the new methods was soon seen: the hides were taken off without cuts and with fewer scores. Hides are used for sole leather, belting leather, and harness leather, and one only requires to think a little to realize, apart from monetary loss, the danger to health and life that may follow in wearing boots or using harness and mill belts made from damaged hides. The slaughtermen don't often think about these things when at work. Not only did the American firms see that tools of the proper class were used, but they had hide inspectors of their own appointed, who examine the hides immediately they are taken off the carcass. Any imperfections are at once shown to the slaughterman, and he is warned to be careful. Should the workmanship not improve, then the man is dismissed and a better workman takes his place. So successfully has this arrangement worked, that at present hides are being sold in the Deptford Market at as high a price as 7½*d.* per lb. This is 2*d.* per lb. more than the value of the carcasses from which they are taken. Comparing the value of a first-class hide and a second-class hide, we observe a difference of ½*d.* per lb., and going further, if we take the average weight of hides as 70 lb., this works out at about 3*s.* per hide; and if the hide is only third-class or damaged, then the loss is still greater. Three shillings on one hide may not seem much; but in abattoirs such as those at Birkenhead and Deptford, where about 200,000 animals are killed yearly, the money lost would amount to thousands of pounds. Some firms allow 2*d.* per hide as an inducement to the slaughtermen to perform first-class work, and as much as 6*d.* per hide has been given. The usual custom is for the butchers to send the hides to the hide merchants, or the latter send for them. On arrival of the hides at the auction marts they are weighed and examined by hide inspectors, who stamp the class on the tail. They are then placed into the various classes ready for the sale. The table on p. 20 shows how they are classified and sold. From those prices, commission, &c., is deducted, and the balance sent to the butchers. The American firms, in addition to improving the flaying of the hides, are now curing them and supplying direct to the tanners, thus displacing the hide merchant or middleman. In the slaughterhouse the skulls and horns are detached from the hide, which is at once inspected for defects

Opening-up Knife



American Pattern Siding Knife

Hide Knives (Herbert & Sons, West Smithfield, London, E.C.

	93 lb. and upwards.	84 to 92 lb.	79 to 83 lb.	74 to 78 lb.	69 to 73 lb.	64 to 68 lb.	55 to 63 lb.	54 and under.
First-class, polled, per lb....	5½*d.*	5½*d.*	5⅜*d.*	5¼*d.*	5*d.*	4⅞*d.*	4⅞*d.*	4⅞*d.*
,, horned ,, ...	5¼	5¼	5⅛	5	4⅞	4¾	4⅝	4⅝
Second-class, polled and horned, per lb.	5	5	4⅞	4¾	4½	4½	4½	4⅜

	Above 60 lbs.	50 to 60 lb.
Cow hides—First-class, polled, per lb.	4½*d.*	4¾*d.*
,, ,, horned, ,, ...	4¼	4½
,, Second-class, horned and polled, per lb. ...	4	4¼

Bull hides, first-class, 3¾*d.* per lb.
,, second-class, 3½*d.* per lb.
Damaged hides, 3⅝*d.* to 4*d.* per lb.

due to bad workmanship. It is then sent direct to the hide stores. There the hides are weighed, and carefully examined for warbles, or, as they are called by Americans, 'grubs', or in London 'bots'. Then the hides are salted in packs, and left for four or five weeks until they are cured. They can be left any length of time according to the state of the market, and are sold when the best price is obtainable, to English, American, or Canadian tanners. After sale, the hides are taken ex pack, the salt is carefully shaken off them, an allowance being made for manure and tare (which is the same as moisture). The hides are now folded into what is called the 'horsehide lap', by which they can be put up into neatly shaped bundles of about 18 in. square; then they are weighed, and shipped to the tanners. Thus hides may, and often do, return to the country where the animals from which they came spent their lifetime. Irish hides were at one time flayed very badly, and many thousands of pounds must have been lost to that country, due to bad workmanship. A few years ago flaying competitions were held, in order to encourage slaughtermen to do better work. The man who proved to be superior to all others was appointed to visit all the large towns in Ireland to instruct the slaughtermen how to take hides off in a proper manner. This has proved of great value, and now some well-flayed hides are sent weekly from Ireland to the English hide marts. Nevertheless a considerable amount of improvement is still necessary in many towns and districts, not only in Ireland but also in Great Britain, before all hides are taken off as they ought to be. The chief points to be attended to in taking off hides are as follows, viz.: (1) A good workman, who has an interest in his work, and prides himself in taking off a first-class hide. (2) The use of proper knives, and also the using of a 'hammer' or 'buffer' on the buttocks. (3) That the hide should be opened up so that it is as nearly as possible square when spread out on the ground. (4) No cuts and no scores, or as few as possible, on the hide.

In the opinion of American experts who have visited all the countries where slaughtering is done, the method of flaying hides at Deptford and Birkenhead is as nearly perfect as possible. See also LEATHER INDUSTRY. [T. D. Y.]

Hieracium, a large genus of Compositæ, popularly known as Hawkweeds, and widely distributed throughout temperate regions. Some of them are troublesome weeds, but a few are worth growing as garden plants, one of the best being *H. aurantiacum*, a native of the Pyrenees, but now naturalized in England; it has a perennial creeping rootstock, elliptical entire leaves, and scapes 1 ft. or so high, bearing corymbose heads of bright orange-red flowers. *H. villosum*, the Shaggy Hawkweed, has its leaves covered with long silky white hairs, and is quite attractive, especially when it is in flower, the heads being large and yellow. Both species will grow in any soil, and almost any position in the garden. [W. W.]

High Farming. See FARMING, SYSTEMS OF.

Highland and Agricultural Society of Scotland.—This, the national Agricultural Society of Scotland, was founded in 1784. Its primary, and indeed almost its sole, object at that time was the improvement of the Highlands and Islands of Scotland. It also included the paying of proper attention to the preservation of the language, poetry, and music of the Highlands. Its original office-bearers included a bard, a piper, and a Professor of the Gaelic language. A Royal Charter was obtained in 1787 under the title of The Highland Society of Scotland in Edinburgh. Two years thereafter it obtained, in terms of an Act of Parliament, a grant of £3000 out of the money paid on restitution of the forfeited estates. Prizes in medals and money were given for the encouragement of the improvement of live stock and different departments of farming, including the reclamation of land. Largely through the influence of the Society, a Bill was passed through Parliament in 1799 giving much-needed relief from thirlage, which constituted a serious barrier to agricultural improvement. Gaelic literature was fostered, and a Gaelic dictionary was published by the Society (2 vols. quarto, 1828). In the opening year of the 19th century, ploughing matches were promoted and subsidized in

Dumfriesshire and Galloway, one of the main objects sought being the introduction of improved ploughs and other new and useful implements of husbandry. Active encouragement was given from an early date to the extension of forestry, and to the most approved methods of carrying it on. All along, until a comparatively recent date, reports and papers on forestry formed a prominent and useful feature of the published Transactions of the Society. Since 1870, on the reports of a board of examiners, first- and second-class certificates of proficiency in forestry have been given, and the Society gives an annual grant to the Lecturer on Forestry in Edinburgh University.

During the earlier years the membership underwent a steady increase. In 1787 the number was 160; in 1799 it increased to 500, largely due to the plan of having district competitions. It steadily grew until, at the close of the war, when people were increasingly inclined to cultivate the arts of peace, it had grown to upwards of 1100.

The first show—designed to be a fat-stock show on the lines of that of the Smithfield Club—was held at Edinburgh at Christmas, 1822. Similar exhibitions were held at the same centre during the three succeeding years, prizes for store stock being added in 1824. A general show of the Society was held at Glasgow in 1826, which was the beginning of the system subsequently followed of holding the annual exhibitions at different centres throughout the country. For about twenty years after the inauguration of the general show in different districts, the social functions in connection therewith were outstanding features. A series of dinners were held on successive days in large marquees erected for the purpose. At these, speeches at once elaborate and eloquent were made by leading statesmen and landowners, and the opportunity was taken advantage of for public discussion on agricultural matters bearing especially on different forms of agricultural improvement.

In 1834 there was obtained a new Charter, in which the name of the Society was changed to that which it has since borne. Originally designed for the benefit of the Highlands, its operations had taken a much wider range, and by this time had embraced every part of Scotland. Its members now numbered 1900. In connection with its second show at Dumfries, in 1837, an English maker was encouraged and assisted in bringing a steam plough to be exhibited at work in Lochar Moss, but the ground proved so soft and treacherous that the plough could not be removed from the place.

At a special meeting of the Society during the show at Edinburgh in 1848, resolutions were passed setting forth the great importance of chemistry and its application to agriculture, and it was resolved to approve of the proposed establishment of a Chemical Department. This was followed by the appointment of a Chemist. Over a series of years the Society had stations at Pumpherston in Linlithgowshire, and at Harelaw in East Lothian, at which experiments were carried on, but these stations were eventually discontinued. In more recent years experiments of various kinds have been conducted under the supervision of the Chemist on farms in different parts of the country, reports of which regularly appeared in the Transactions of the Society.

Previous to 1823, Mr. William Dick—afterwards widely known as Professor Dick, the founder of the Royal Dick Veterinary College in Edinburgh—had lectured on veterinary subjects in the capital. In that year the Highland Society, recognizing his high qualifications and the usefulness of his work, subsidized that eminent teacher to a moderate extent. The Society was instrumental in 1838 in getting Professor Dick's graduates recognized as eligible for commissions as veterinary surgeons in the Queen's army and in the army of the East India Company. For many years the Highland Society conferred certificates in veterinary science. In 1879 a definite arrangement was concluded between the Society and the Royal College of Veterinary Surgeons, London, under which the holders of the Society's veterinary diplomas were admitted as members of the Royal College, and since 1881 no veterinary examination has been held by the Society.

The Highland and Agricultural Society has long taken a warm and active interest in agricultural education. The Chair of Agriculture in the University of Edinburgh was instituted at the end of the 18th century with the modest endowment of £50 per annum. About forty years ago the Society obtained from the Exchequer an annual grant to the occupant of the Chair of £150, on condition that the Society contributed a similar amount. This was continued until the present arrangement was carried out of pooling the revenues of the various chairs in one common fund, from which the salaries of the Professors are paid. In 1856 a supplementary Charter was granted, under which the Society conducted examinations and granted diplomas in agriculture. This continued until about 1900, when the existing arrangement was made, under which a Joint Board from the Royal Agricultural Society of England and the Highland Society have conferred what is known as the National Diploma in Agriculture (N.D.A.).

For many years Scotland has been divided into eight show districts: (1) The Lothians, (2) South-east of Scotland, (3) South-west of Scotland, (4) West of Scotland, (5) District around Stirling, (6) Perthshire and adjoining districts, (7) North-east of Scotland, and (8) Inverness-shire and north-west of Scotland, and annual shows have been held in the month of July at some centre within these districts in successive years. The sums given in prize money at general shows from the funds of the Society amount to upwards of £2500 annually, and this is largely supplemented by liberal special prizes generally offered by private individuals and societies. In addition, from £600 to £700 are annually given as district grants to local agricultural societies in all parts of Scotland. In connection with many of these grants it is stipulated that in alternate years, when the prizes from the national society are suspended for the year, prizes

of an equal amount must be offered out of the funds of the local society.

The membership of the Society in 1909 numbers 6829. The funded capital of the Society has been steadily on the increase, and now amounts to about £110,000. There are two grades of subscription. The higher annual subscription is £1, 3*s.* 6*d.* Life members pay £12, 12*s.* Proprietors farming the whole of their own land, not exceeding £500 in annual value, and all tenant farmers, secretaries or treasurers of local agricultural societies, factors resident on estates, land stewards, foresters, agricultural-implement makers, and veterinary surgeons, none of whom are owners of land to the value of £500 per annum, are admitted on a payment of 10*s.* per annum, or a single life subscription of £7, 7*s.*

Not unnaturally, for a lengthened period the management of the affairs of the Society was to a large extent in the hands of gentlemen whose residences were within easy access of Edinburgh, and it was felt as a grievance that comparatively few tenant farmers were admitted as members of the Board. Since 1882 the election of the directors has been put on a representative basis. In addition to the office-bearers, the Board consists of 52 directors; 32 of these are ordinary directors, 4 being from each show district, each of whom holds office for four years. One of these is nominated by the members in each show district each year. Of the 20 extraordinary directors, 10 are chosen from the district in which the show for the year is to be held, and the other 10 are chosen because of their known interest in, and their work for, the Society. One-half of the directors in each of these classes must be landed proprietors or other persons paying the higher subscription, and the other half must be tenant farmers or other persons paying the lower subscription. [J. G.]

Highland Cattle.—These cattle are now to be found chiefly upon the western mainland of the Scottish Highlands and on the islands along that coast, but there are some herds in Perthshire; also in Inverness and Ross and Sutherland, and in other districts on the east side of Scotland. They are the domestic and native breed of the western Highlands, specially fitted by nature to survive in the climatic and other conditions surrounding their existence. Originally they were known as 'Kyloe', which is said to be a corruption of the Gaelic word for Highland, but by other writers it is maintained that the name applied to the Island cattle alone, because they had to be taken over so many ferries, which were locally known as 'kyloes'. Even to-day there exists some discussion on the question of designating them as West Highland instead of Highland, but it is believed that the authorities favour the latter description as being more correct. Earlier writers usually refer to the 'Highlanders' as 'Black Cattle', and the prevailing colour in the 17th century was either this colour or a dark-dun shade. A general belief prevailed that jet-black animals were hardier and scaled heavier weights than others. White marking, or 'chaisfhionn', was curiously reckoned a good point, particularly in breeding milking cows. Other colours doubtless existed at that period, but they were to be found more in Perthshire than elsewhere. The 'Kyloes' or 'Black Cattle' were not, as a rule, kept under cover; they were allowed to remain outside both in summer and winter, and the death rate was very heavy. No effort was made to cultivate winter fodder or to preserve grass for winter keep. It was only about the year 1756 that Balranald, who had settled in South Uist, introduced the custom of securing hay for the sustenance of the stock in the severe period of the year. A writer travelling through the country in 1776 gives the following description of the breed and their habits:—

'Those groups of cattle were picturesque wherever we found them, though we found them less frequently than we could have expected in a country which is totally pasturage, for although the district be wide the herbage is scanty. The animals, therefore, unable to feed gregariously as nature inclines them, are obliged to ramble apart and pick up subsistence where they can. The cattle themselves, as individuals, are in general homely. Their colour is commonly black with patches of white, which make together the most unharmonious of all mixtures. They are small, their countenances usually sour, their horns wide—very unlike the small, curled, beautiful horns of the Alderney and French cow. But these deformities are of little consequence in a group.'

In the 18th century the current idea was that these cattle should be round in the body, broad on the back, with a thick coat of hair; but it is recorded that their weight when fat did not exceed 20 Dutch stone on farms of first quality, while on other holdings they were only from 15 to 17 st.; the Dutch stone being equivalent to $17\frac{1}{2}$ lb., the weight would only be from $2\frac{1}{2}$ to 3 cwt. at that time. All this is entirely altered now, as will be seen presently.

In the early part of last century, farmers began to devote more attention to the breeding and feeding of the 'Highlander'. This movement was first discerned in the islands of Islay, Colonsay, and Jura, where the people, wisely led by the landowners, began to exchange bulls and to purchase them from elsewhere, always competing for size as well as quality. On these islands—particularly on Islay—the land is rich, and with good feeding the capabilities of the 'Highlander' began to evince themselves. This improvement led naturally to better prices, and the knowledge of increased returns at markets for certain strains gave an impetus to others to emulate the example of their more advanced neighbours. Herds were gradually formed, of which Balranald is probably the oldest, the Macdonalds having farmed there for twelve generations. They reared from the true native Kyloe breed, and an animal, Seillein, a bull, born in 1806, is one of the first entries in the Herd Book of the Highland Cattle Society. Another, Morchius, was calved in 1810. On the mainland, perhaps the first fold properly installed was at Poltalloch in 1790, and from there Colonel Malcolm still is a successful exhibitor at the Highland and other shows. In Glenlyon over

a hundred years ago there were excellent Highland cattle, and likewise in the Trossachs. From Glenlyon the Stewarts migrated to Park, in the island of Lewis, and subsequently, in 1809, to Luskentyre, in Harris. They introduced Perthshire bulls, and gradually collected what afterwards became, and still is, the famous Ensay stock. Jura, Colonsay, and Bochastle produced notable cattle, and the Breadalbane, Gordon, Chesthill, Eoligarry, and other herds were created—all tending to the development of a stronger strain, and an extensive interchange of animals for breeding. The Duke of Sutherland, in the north, assisted in the movement, and by the year 1870 there was little left to be done to raise the standard of the old 'Kyloe', for Seafield, Dunmore, Athol, Minmore, Monzie, and Benmore were making progress. Also, in Argyllshire, Melfort, Ardsheal, Ardanaiseig, Ardtornish, Achnacloich, Canna, Kilchamaig, Rum, and others made headway; while in neighbouring counties breeders were found such as Southesk, Cammusericht, Shinnes, Ardross, Airthrey, Dunmaglass, Strathaird, Farr, and more recently Garth. The one regrettable aspect of the rearing of the breed has been the ever-recurring necessity for dispersion sales. From one cause or another, herds, after years of careful selection and management, have had to be broken up. No doubt others benefited by these changes, but such breaks in the continuity of rearing have caused the loss of peculiar, and in some cases valuable, characteristics of the race. Through the untiring efforts of the late Lord Dunmore, who died in 1907, a meeting was held in the show yard of the Highland and Agricultural Society in Edinburgh, on the 24th July, 1884, when it was resolved to form the Highland Cattle Society of Scotland. This gave the requisite impetus to the further improvement of the breed, and the first or retrospective volume of the Herd Book was published in the following year. The last volume, No. xv, was issued in 1908, and the number of entries at the close of it was 2351 bulls and 7488 cows and heifers. In it are to be found cattle from such old folds as Jura, Balranald, and Poltalloch.

The Highland animal of the present time is a very different beast from the 'Kyloe' of two hundred years ago, but it must be remembered that the climatic conditions under which he exists are little altered. The improvement has been brought about mainly by breeding, feeding, and housing; and it is questionable whether the treatment now adopted, particularly by the richer breeders, has not had a detrimental bearing upon the profit-producing properties of the race. The 'Highlander' left out all the year round, with a small allowance of straw or hay in winter, is not expensive to keep. Nature has provided him with the constitution for such an existence, and when he is taken south to feed he rapidly improves upon the richer grasses. Such cattle in older times were in demand for southern feeders, for their price was moderate and their improvement was certain. Now they are sheltered and fed on cake and other artificial products, and while larger in size, they do not improve so rapidly when taken south, but they cost more to both rearer and purchaser, and have not the weight or the 'outcome' of other breeds, such as the Shorthorn. So much is this the case, that it is now doubtful whether it is profitable to rear them, and not without reason it is suggested that they have reached a stage when they might with more advantage be crossed with another kind, which would improve their weight-producing quality. The 'Highlander' was created to stand the stress of exposure in a country where the land is rough and high, and in many parts poor, where the rainfall varies each year from 50 inches in Kintyre to 162 inches in West Ross, and where from 80 to 100 inches per annum is by no means unusual.

Description. — In the Herd Book (vol. i) there is a general description of the breed, from which some of the following notes are extracted. It is claimed that the 'Highlander' was an aboriginal breed pertaining to Scotland. However this may be, it appears certain that it is the true native of the Highlands and Islands. At first there was a difference in designation. The island cattle were called 'West Highland' and the mainland animals 'Highland'. This distinction was at one time of some importance, because the mainland stock was larger, heavier, and of greater value than those from the islands. In colour, also, there was more variety on the mainland, the predominating black or dun being superseded by red and yellow in varying shades, and brindled. The first bulls of brighter colour are believed to have been sent to the islands from Perthshire.

In judging the stock, the following main points are considered:—

Head.—The face is broad between the eyes, and short from the eyes to the point of the muzzle. The forelock between the eyes should be wide and bushy. The eyes ought to be bright and spirited. Jawbones should be strong and in proportion with the width of the head in front. The muzzle, when looked at sideways, should be short, and the nostrils fully distended. The horns should be strong in bulls and come level out of the head, slightly inclining forwards, and also slightly rising towards the points.

In cows, the horns ought to come squarely out of the head, and rise more quickly than in bulls. They should be long, and on both male and female they should be highly vascular and pink for some distance outwards from the roots, and have a rich 'sappy' appearance to the tips. The ears should be prominent, with long wiry hair.

Neck and Shoulder. — The neck should be clear, without any dewlap below, forming a straight line from the head to the shoulder in the cow, while in the bull it should have a distinct crest. The crest should come down gracefully to the roots of the horns. The shoulder should be thick and well filled out as it descends from the point to the lower extremity of the forearm.

Back, Body, and Hind Quarters.—The back should be straight and fully developed, and the ribs should spring well out and be deep and curved. There should be good breadth across the hips, and the quarters should be set square on the back and down to the legs, and well

developed from the hips backwards. The thighs should also be very fully developed. The legs should be short and firm, with broad, straight, strong bone. The hoofs should be large and well set in.

Hair.—The hair, like the horn, is a particular feature of the animal. It should be of a healthy, glossy growth, thick, and in parts long. It should not be curled, but should slightly wave. The forelock ought to be full, but not so large as to cover the eyes, and the legs should be nicely feathered. When the animals are fed outside, the hair is more abundant, and in better order than when they are housed. The skin should be fairly thick.

General. — The 'Highlander' is a dignified, well-stepped animal, and the carriage of the head and general bearing adds much to the complete effect. For characteristic carriage it should be wide set between the forelegs.

Management.—As a general rule, the cows are kept solely for breeding purposes, and the calves are allowed to suck their mothers. In only isolated cases is the milk used for domestic purposes. It is of excellent quality and rich in cream, but the quantity is small, about 2 gal. per day, which prevents the general sale of it for trade purposes. Heifers should not be served by the bull until three years old. The period of gestation is from forty to forty-one weeks, and it is desirable that the calves should come early in February or March. The calf goes with the cow to the hill in May, and neither mother nor offspring should get any hand-feeding until they are brought into the byres in November following. When the calf is weaned, which is usually done in November or a little earlier, it is put on good grass for one or two weeks, and then housed at night, when turnips are given evening and morning with some hay. During the day they are grazed outside. Two- and three-year-old heifers are left out winter and summer, but during winter they are given a sheaf of corn night and morning. Bullocks are treated much in the same way. Cows after calving, when in byre, get meadow hay twice before noon, some turnips during the day, and two bundles of straw about 5 o'clock and 8 p.m. This treatment is usually adopted where 'show' stock is not reared, but variations are not uncommon. There are some places where small allowances of cake are necessary. Cows get from 22 to 24 lb. of hay and 50 lb. of turnips daily, or if fed with straw, 24 to 27 lb. of it, with perhaps 60 lb. of turnips. Some people give cows after calving, 2 or 3 lb. of cake, or crushed oats. Two stirks, it is reckoned, can be wintered on the allowance of one cow. Two- or three-year-olds should thrive upon two-thirds of the allowance of hay or straw given to cows, but much depends upon the land, and the quality of the grazing. To keep cattle healthy and the hair in proper condition, they should be washed twice during winter with carbolic, which kills lice and other parasites, at the same time stimulating the growth of hair. Whether for ordinary purposes or for exhibition, care should be taken to select the stock heifers from strains that have proved regular breeders and good milkers, for both these attributes are almost more essential to the maintenance of quality than promising appearance. Cattle intended for competition at shows require a great deal of attention. They have to be separated from the rest of the herd from the time of weaning, and steadily fed, winter and summer, with cake or other artificial food. But the feeding and treatment tends to the destruction of the coat of hair, without which the animal is useless in the show ring. Cattle prepared for the fat shows undergo exceptional treatment. They are usually taken in from the grass in November, when they are one year and nine months old. They are then kept in a loose box for twelve months, being well fed all winter and early summer, and gradually forced from September prior to the show. In this year they gain from 6 to 8 cwt.

At Smithfield Club Cattle Show in 1893 there were only two classes for Highland Cattle, viz. steers or oxen, and heifers or cows. The best weight of the former was 17 cwt. 4 lb., and the lowest 13 cwt. 1 qr. 16 lb. The heaviest in the other class weighed 15 cwt. 2 qr. 15 lb., and the smallest was 11 cwt. 3 qr. 22 lb. The following are the weights of animals exhibited at subsequent shows at Smithfield:—

Steers not over Three Years Old

	Highest.			Lowest.		
	cwt.	qr.	lb.	cwt.	qr.	lb.
1898	14	2	17	10	2	8
1903	14	3	2	11	3	16
1907	13	1	8	11	1	24

Steers or Oxen over Three Years Old

	cwt.	qr.	lb.	cwt.	qr.	lb.
1898	17	3	17	13	3	2
1903	17	1	21	14	2	10
1907	18	1	24	13	0	3

Heifers not above Four Years Old

	cwt.	qr.	lb.	cwt.	qr.	lb.
1898	14	0	18	10	0	14
1903	14	1	14	11	3	2
1907	14	0	8	11	1	25

It will be noted that in the above period of fourteen years no great improvement is evidenced in the weight-producing results of feeding. The beef is sold from £2 to £2, 5*s.* per cwt., but for the prizetakers much higher rates are obtained. Two-year-old beef usually fetches from 2*s.* 6*d.* to 5*s.* more than the flesh of the three-year-old. The average weight of a two-year-old Highland bullock taken off grass, without any artificial feeding, is about 300 lbs., and that of a three-year-old bullock from 400 to 450 lb., dead weight.

Markets.—In olden times, and for the greater part of last century, the cattle were chiefly driven to the local markets, or to the larger fairs at Doune, Dumbarton, and Falkirk, and there disposed of for cash to dealers, who generally transported them to England and to the richer lower lands of Scotland, where, after less generous forage at home, they rapidly improved in weight and value. The modern innovation of the auction mart has almost put an end to the trysts and fairs, and now the recognized

Photo. A. Brown & Co.

HIGHLAND BULL—"AN SEANALAIR RUADH"

PRIZE WINNER AT THE OBAN BULL SHOW, 1909

Photo. A. Brown & Co.

HIGHLAND HEIFER—"LAOCHAG"

BREED CHAMPION AT THE H. & A. S. SHOW, 1905

centre for the sale of the breed is at Oban, where Mr. Thomas Corson opened the West Highland Auction Mart in 1884. They are, of course, also sold at Perth, Stirling, Inverness, and other places, but at Oban the annual bull and other pedigree sales, organized by the Highland Cattle Society, are regularly held. As an indication of the gradually increasing importance of these sales, Mr. Corson in 1887 sold only 944 bullocks and heifers, while in 1897, 5877 was the muster; and Messrs. Thomas Corson & Co. in 1907 passed 10,123 through the ring.

The average auction prices at Oban of the bullocks and heifers are given hereunder:—

BULLOCKS

	Three years.			Two years.			One year.		
	£	s.	d.	£	s.	d.	£	s.	d.
1887	9	7	9	7	2	6	3	10	8
1892	11	4	10	8	1	10	5	4	3
1897	11	16	9	9	11	4	7	3	2
1902	12	5	6	9	6	11	7	1	10
1907	11	5	9	8	13	8	6	2	2

HEIFERS

	Three years.			Two years.			One year.		
	£	s.	d.	£	s.	d.	£	s.	d.
1887	8	4	6	6	6	3	3	9	9
1892	9	16	8	8	3	0	4	15	0
1897	10	2	8	7	16	5	5	10	9
1902	10	10	1	8	9	4	5	18	7
1907	9	15	7	7	19	3	5	15	8

At the present time, when live stock in the market is usually bought for weight and not so much for quality, and when everything is done to make beef quickly and at an early age, the Highland breeder is faring badly. The fattening properties of the animal are not so well adapted to rapid development as those of other breeds, and the frame of an animal originally reared on hard, cold land and in a rigorous climate is not so largely formed as the other species of the bovine kind. The Congested Districts Board have, by the purchase and distribution of good bulls among the crofters in the Highlands, improved the stock raised by small tenants, who now secure prices distinctly in advance of those obtained some years ago.

Upon an Argyllshire island, for many years Highland cows were crossed with Shorthorn bulls. The result was an excellent cross, with much of the hardy nature of the 'Highlander', a first-class feeder, with a 'growthy' appearance. These crosses always sold well, and usually in advance of pure-bred 'Highlanders' of the same age.

The 'Highlander' has not made any great progress in other countries or in our colonies, and little can be traced to their credit in the sphere of exportation. There is no demand for them in Argentina, where so many of the Shorthorn breed have been transported, with great profit to our rearers at home. About twenty-five years ago Lord Strathcona and Mount Royal took out to Canada a West Highland bull, Alastair Ruadh, which is one of the earliest entries (No. 9) in the Herd Book, and with the bull about twenty cows of the same breed. Commercially this was unprofitable. The herd was first grazed on Lord Strathcona's Silver Heights territory in Manitoba, and was subsequently handed over to the charge of the Land Commissioner for the Canadian Pacific Railway, the animals being kept at a place called Forres, in what is now the Saskatchewan Province; but they have apparently, with this opportunity, been found wanting in adaptability or usefulness in the Dominion. [J. D. S.]

Highland Pony.—The small Highland pony of the Outer Hebrides is perhaps one of the oldest breeds in existence, and from it, without doubt, all the other varieties of Highland pony have sprung. In considering the Highland pony we must divide the breed into three classes or sections: First, the small pony of the Outer Hebrides; second, the larger pony of Tiree, Mull, Skye, and Uist; third, the so-called Garron of the central Highlands.

Of the *First* section—the small Highland pony—the Barra pony may be taken as the type. Most of these ponies might be called plain useful animals, but here and there a very beautiful little pony may be found. Their points are: a plain square head, rather long; a good prominent eye; a rather short neck; shoulder a bit straight, but very freely used; deep at the heart; good back; rather a short quarter and sickle hocks; legs good, with a very good quality of bone, and very good open feet. Height from 12 to 13 hands on ordinary Barra keep, but if well done they may grow a bit higher. Many years ago there were to be seen some very beautiful little ponies, with a decided Arab look, on some of the small islands. The writer specially remembers one from the island of Rona that looked like a little racehorse. There is no doubt these ponies must have had a strong Arab cross at some time. Colours dun, grey, black, brown, with some bays and chestnuts. As roads increase and carts take the place of creels the cry is all for a bigger pony, and at present an attempt is being made to increase the size; but this is a great mistake, as to grow bigger ponies they must have better keep, or substance and stamina will be lost, and as things are, the ponies cannot look for any better keep than they have at present. Besides, there is a demand for small hardy ponies for small tradesmen's carts, the small pony being easy to keep and to house. There is likely to be a great future for these small ponies for carrying the guns of the mountain batteries, and the writer has the best authority for saying that ponies 12 to 13 hands high are the most suitable for this work. In former years a number of foals were bought by dealers in Barra, but recently a great many of the foals have been taken to Oban and sold at the auction mart there.

Second.—We now come to the larger pony of Mull, Skye, Uist, and Tiree, which we will refer to as the Mull pony. In all these islands there are a few ponies of the so-called Garron type of the central Highlands, but these ponies are the result of some cart-horse cross. The pony we will describe here, however, is of a distinctly riding type, and though common in the islands forty years ago, has now almost become extinct. There are two engravings of these ponies in the Sports-

man's Magazine of 1858 that give one a very good idea of their conformation. Though quite strong enough to do all the work on a croft or small farm, they were decidedly of a riding type. The description of one of the engravings was 'A good cart mare', which proves that they were used for farm work. The points of the Mull pony are: fine Arab head, long fine neck, well-laid shoulder, well-sprung ribs, with the best of legs and feet; in their trot they go a bit wide behind; they stand from 13·3 to 14·2. Colours dun, grey, black, with a few bays and chestnuts. The chestnuts were principally found in Uist. In Tiree this pony is now entirely crossed out; indeed there are very few left in any of the islands. It is much to be regretted that they have so nearly disappeared, as they are most valuable for military purposes, being up to weight, hardy, and fast, and can carry their saddles in the proper place. Anyone having ponies of this type would do well to take great pains to keep the breed pure. There are still a few mares bred from these ponies and a Clydesdale horse. Some first-rate riding ponies have been bred from Arab stallions and pure Highland mares, and for long-distance hacks they cannot be beaten. There is a theory that these Mull ponies were descended from Arab or Barb horses wrecked from the Spanish Armada. There is no doubt that there is a strong cross of Eastern blood in them, as in all the ponies on the west coast of Great Britain right from the south of England to the north of Scotland, and also in the west of Ireland; in fact nearly all the native breeds of ponies in Great Britain and Ireland are on the west coast on the track of the Armada, and all these pure old breeds have a great resemblance to one another. Of course, each has its own special characteristics according to its surroundings. In former times there was a breed of ponies in Galloway just the same as the Mull type. In Cumberland they were always called Galloways, in fact in West Cumberland the farmers used to call all ponies 'Galloways'. Sir Walter Scott gives a capital description of them in Dumple, Dandy Dinmont's famous pony. In describing Dumple he just describes the old Mull type of pony.

We now come to the *third* type, the pony of the central Highlands, generally called a Garron. The Garrons are powerful little horses rather than ponies. They stand about 14·2 and sometimes up to 15 hands, but at that height they lose a great deal of the pony character. Most of them have nice clean heads, with bold eyes, but in some cases they exhibit traces of the Roman nose and cart-horse type of head. Both horses and mares have fine strong crested necks; rather heavy loaded shoulders, some fairly well laid; good strong backs, though in many cases a bit long; good strong quarters; bone of legs a bit round. They are all through good, strong, useful animals, very suitable for all hill farmwork and for carrying deer, but it is quite evident, and admitted by many, that they must have had a strong cross of Flemish blood at some time. A common idea is that, before 1745, small ponies were distributed all over the Highlands and were the only horses in use, and that during the unsettled times in 1745, big horses were brought up to the Highlands by the cavalry, and some of these big horses were left in the Highlands and crossed with the native pony, and so produced the Garron of to-day. A very good-looking Garron can be produced by crossing a neat small Clydesdale with an old-type Mull pony mare. The late Sir Robert Menzies never looked on the Garrons as a real breed of Highland pony. He used to say, if in Perthshire they wanted a good, hard, Highland pony, they were wont to go to Fort William to meet the drovers bringing ponies in from the western islands. As time went on and cultivation improved in the central Highlands, keep became more plentiful, and the ponies were better managed — a circumstance which also tended to increase the size; but this has caused a loss of true pony character. It seems that to preserve true pony character a certain amount of hardship is required.

From all this it seems that the small pony of the outer islands in the west is the true Highland pony, and the other two larger types are the result of some crossing and an improvement in keep, the Garron to a greater extent than the Mull pony. The late Mr. Cameron of Corobоilie had a wonderful breed of skewbald and piebald ponies, which were descended from a pony that came from France and the mares of their own district. No doubt the pony from France was a Barb or Arab brought to France from Algiers. These ponies were wonderful stayers. The late Mr. Cameron rode one of them from Inverness to his home in Lochaber and back again in some extraordinarily short time. It is to be feared that this breed has quite died out; the last the writer saw of them was a very beautiful old mare in the Glen Artney stud.

There is a great future for all the three types of Highland ponies. The South African war opened the eyes of the army to the good of the pony in warfare: the little pony of Barra for mountain-battery work, the Mull pony and the smartest of the Garrons for mounted infantry and yeomanry, and the heavier Garrons for draught work. [J. H. M. M.]

Highways.—Ways over which all the king's subjects have the right to pass and repass are called highways. A highway is not limited to a cart-way or carriage-way; it may be a bridle-way or mere foot-way, and there may be a good right of way although there is no clearly defined road, as in a case where persons have from time immemorial found their way across a common, sometimes by one track, sometimes by another. It is prima facie a way that leads from one public place to another, although a *cul-de-sac* in a town may be a highway; but in the country the mere transit of persons to see a view or some object of interest will not create a right of way. Thus, in Attorney General *v.* Antrobus (1905, 2 Ch. 108) it was held that there was no public right of way to visit Stonehenge.

Whether a particular way is a highway or not is a matter of fact to be determined by evidence. Evidence of user by the public for so long, and in such a manner that the owner in fee must have been aware that the public were acting under

Photo. A. Brown & Co.

HIGHLAND PONY COLT—"SKERRYVORE"
WINNER OF PRESIDENT'S MEDAL, H. & A. S. SHOW, 1907

Photo. C. Reid.

HIGHLAND PONY MARE—"BRAULIN"
WINNER OF PRESIDENT'S MEDAL, H. & A. S. SHOW, 1908

the belief that the way had been *dedicated*, is not conclusive, but it is evidence on which dedication by the owner may be proved. There must, however, be actual dedication or an intention to dedicate on the part of the owner. Merely acting so as to lead persons into the supposition that a way is dedicated does not of itself amount to dedication (Barraclough *v.* Johnson, 8 Ad. and El. 99).

The dedication of a right of way to the public will not be inferred from the public use of country paths by permission for the purpose of pleasure (Behrens *v.* Richards, 1905, 2 Ch. 614). There may in law be a dedication to the public of a right of way such as a footpath across an arable field, subject to the right of the owner of the soil to plough it up in due course of husbandry and destroy all traces of it for a time. Such public rights of way subject to the right of ploughing are not uncommon. When a public roadway runs between fences, the public prima facie, unless there is something to show the contrary, have a right to use the whole space, and are not confined to the metalled part (Offin *v.* Rochford Rural Council, 1906, 1 Ch. 342).

The soil of a highway is, however, in ordinary cases not vested in the local authority whose duty it may be to repair the highway, but remains the property of the landowner or his successors over whose land it was made. The owner may exercise all rights of ownership over the land not inconsistent with the right of passage of the public, such as the right of pasturage, or cutting the grass on strips of grass adjoining the metalled roadway. The public have no right to use the highway except for purposes of passage. In Harrison *v.* Rutland (Duke) (1893, 1 Q. B. 142) the highway crossed a grouse moor belonging to the defendant. On the occasion of a grouse drive the plaintiff went on the highway, not for the purpose of using it as a highway, but solely for the purpose of using it to interfere with the defendant's enjoyment of his right of shooting, by preventing the grouse from flying towards the butts occupied by the shooters. It was held that inasmuch as the plaintiff was on the highway for purposes other than its use as a highway he was a trespasser.

Where closes of land adjoining a highway on either side belong to different owners, the presumption is that the soil of the highway belongs to the adjoining owners, each owning the part adjoining his close up to the centre of the way.

Where there has once been a public highway, no length of time during which it may not have been used will extinguish the rights of the public — 'Once a highway always a highway. But it may be closed or extinguished by statute; and the Highway Act, 1835 (5 & 6 Will. IV, c. 50) enables highways to be stopped up, diverted or turned by order of the Court of Quarter Sessions, to be made upon the certificate of two justices of the peace. Under the Local Government Act, 1894, sect. 13, the consent of the parish council and of the district council is required for the stopping, in whole or in part, or diversion of a public right of way within a rural parish.

The duty of repairing highways was formerly cast upon the inhabitants of the place where they were situate. Now, generally speaking, highways in urban districts are repairable by the borough or urban district councils, in rural districts by the rural district councils. The Local Government Act, 1888, transferred the duty of repairing 'main roads' to the county councils. A parish council may, under the Local Government Act, 1894, undertake the repair and maintenance of public footpaths (other than those at the side of public roads) in their parish.

[A. J. S.]

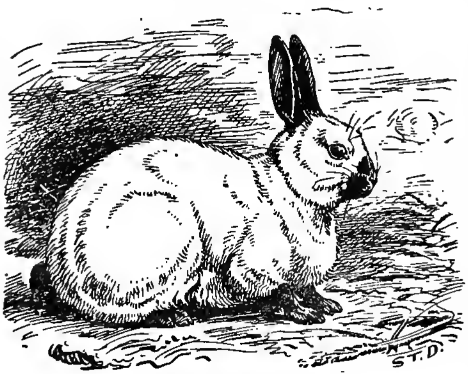
Highwood, originally called *Saltus* in legal terminology, to distinguish it from the *Sylva cædua* or coppice (with or without standard trees), consisted of all such portions of woodland (*Boscus*) as were allowed to grow up as a timber crop to over twenty years of age. This legal distinction is important, because, although under Scots law an heir of entail can during his tenure clear an estate of timber, under English law money arising from the sale of timber on entailed estates must be treated as capital vested in the trustees, and only the interest arising from its investment is enjoyed by the tenant-in-tail. But in modern forestry the term 'highwood' or high timber is usually applied to woods grown from seed (by natural regeneration, or by sowing or planting), and not intended to be cut until the trees have arrived at the dimensions of timber, *i.e.* when the top end of the bole has a minimum diameter of 6 in. And it is the only manner in which coniferous trees can be grown, as they do not spring from the stool like broad-leaved coppice. If highwoods or timber crops be formed with plants set at from about 4 to 5 ft. apart (2722 to 1742 per acre), and kept in close cover as they grow up, without being over-thinned, the trees will attain their greatest length and produce the largest total basal area at breast height for the stems forming the crop; and when, after judicious thinning, the crop attains maturity, the trees should be of large dimensions, though of course the length, girth, and volume of the individual stems and the total bulk of the crop will vary greatly according to the quality of the soil and the situation. In comparison with simple or with stored coppice, highwoods require a far larger capital, represented by the growing stock of immature crops of all ages; and in order to have regular annual falls yielding an approximately equal amount of timber year by year, these age classes must be distributed throughout the woodlands proportionately. In the case of trees like Larch, Spruce, and Pine, where the mature crop is usually clear-felled and renewed by planting, this means having a regular succession of crop areas from 0 up to the age at which the mature timber is felled; but in woods consisting of Beech, Oak, Silver Fir, and mixed crops of broad-leaved trees, in which natural regeneration from seed produced by the parent trees on the area itself is usually carried out for the chief tree in the crop, and then the other kinds of trees are introduced into this new matrix by planting, so many annual falls are grouped together (usually twenty to thirty in the case of Beech, and sometimes even more in the case of Silver Fir, the two trees

chiefly treated in this particular manner on the Continent) to form 'periodic falls' as there are years in the period throughout which this process of natural regeneration with simultaneous gradual clearance of the parent standard trees is intended to be accomplished. The simplest form of highwood, however, is that in which the whole woodland is regularly divided into equally productive annual falls, the oldest of which is clear-felled every year and then a new crop formed artificially—and almost always by planting, in Britain. This is the customary method of treating most crops of coniferous timber trees (Larch, Pine, and Firs of the various kinds).

[J. N.]

Hill Farming. See FARMING, SYSTEMS OF.

Himalayan Rabbit. — This is a well-known variety of rabbit possessing distinctive points of beauty. It is of a hardy nature, and breeds well in confinement. Like many other species, its origin is very uncertain. Whether it had originally any connection with the mountain range of the same name is doubtful. It is possible that, following the western trend of the human race, it may have passed, along with them, from an Asiatic to their European home; or it may have been brought by the invaders of India or Persia to the regions that border the Mediterranean. However that may be, this variety of rodent is firmly established now amongst us, and is kept in considerable numbers by British fanciers. Though presenting many points of



Himalayan Rabbit

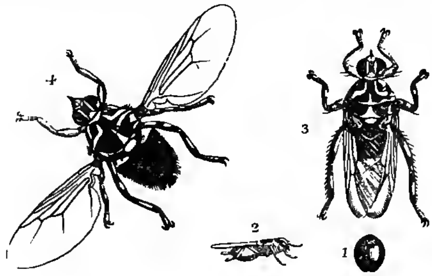
resemblance to the Polish rabbit, it has nevertheless distinctive features of its own which may be summarized as follows: Colour of body, white with very dark or black markings, the value of the variety being greatly enhanced by the richness of these. These black patches, or 'points' as they are called, should appear sharply defined upon the muzzle, ears, tail, and feet, though in the last-named they are frequently 'blurred' or ill-defined, and frequently wanting. To secure these desiderata it is advisable to breed only from such specimens as clearly exhibit these markings, and at the time when they are at their best in coat and colour. The head should be of medium size; ears short and held erect; coat glossy; eyes should have a bright-pink hue. Correct weight about 5 lb. The doe is best mated with a young buck of about one year or so. Period of gestation thirty days. Two or three litters may appear in the course of one year. Being of a quiet disposition, the doe is usually a good mother, though rather jealous of her young. Prices range from 7*s.* to £3 or £4.

[F. T. B.]

Hinny, the offspring of a stallion and a she-ass. See MULE.

Hinting, an operation in ploughing. See PLOUGHING.

Hippobosca equina (the Forest, Horse, or Spider Fly).—These singular creatures often



Hippobosca equina (Forest Fly)

1, Pupa; 2, the fly, natural size; 3, 4, magnified.

swarm upon horses in forests during the summer, especially upon those of a white colour. They tickle spirited horses unaccustomed to them to such a degree that they are dangerous visitors, but when used to them the animals do not seem to suffer much annoyance. Their economy is very remarkable, for the fecundated female does not lay eggs nor produce young; but an egg hatches in her body, and the young insect is nourished and grows there, enveloped in a whitish leathery case; in this it changes to a pupa, which is at last brought forth, and soon becomes hard, black, and shining like an ebony bead (fig. 1); in this the fly is concealed, and soon bursts open a lid at one end to be released from its prison. The flies rest with their wings upon their backs (fig. 2), run swiftly hither and thither, and often take short flights when disturbed; they are shining yellow, variegated with black and brown; the body is dirty brown and shrivelled, or pale and globular in the gravid female; the legs are stout and ochreous, spotted with brown; the claws are black, strong, and hooked. Many of the Hippoboscidæ are wingless, and the insect commonly but wrongly known as the 'sheep tick' or 'ked' (*Melophagus ovinus*) belongs to this group.

[J. C.] [C. W.]

Hippophaë (Sea Buckthorn or Sallow Thorn).—*H. rhamnoides*, a large deciduous shrub or small tree (nat. ord. Elæagnaceæ), native of Europe (Britain) and Asia, is of considerable value for garden cultivation by reason of its handsome orange-coloured berries, which persist throughout the autumn and winter months. To secure these it is essential to grow a male among the female plants. The leaves are silvery underneath. *H. salicifolia*, the Himalayan species, differs but slightly from *H. rhamnoides*.

Propagation is usually effected by layers, suckers, or root cuttings. [W. W.]

Hippuris, a marsh plant, readily recognized by its whorls of small undivided leaves. See MARE'S TAIL.

Hiring. See MASTER AND SERVANT, also EARNEST.

Hirsel.—This term is applied to the part of a large pastoral farm under the charge of one shepherd, and practically means his herding. It is used also to denote the sheep under the charge of a shepherd, and may include two or more 'hefts' (which see). The number of sheep which one man can look after varies according to the ground. If the farm can be easily seen, and is of good quality, so that more sheep can graze on less ground than is the case on poor land, a competent man may very well have a hirsel of 500 to 600 breeding ewes besides 125 to 150 young sheep or hoggs under his charge. On rough, or steep, or poor grazings, on the other hand, probably 400 ewes and 100 hoggs will be nearer the number he should be expected to tend. In lambing time, a hirsel of the size described will require the attention of two men, but the number of sheep that can be allotted to a man depends more on the nature of the ground, and the conveniences available, such as lambing pens, shelters, &c., than on anything else. Every shepherd has his own way of herding his flock, and although the master may very properly give general directions, the details must be left to the discretion and judgment of the man in charge. During the early months of the year, except in time of storms, hill sheep need little attention, and the less they are disturbed the better; but during the lambing season, April and May, and until they are clipped in July, the hill must be regularly visited at least twice daily. Thereafter, unless where maggots are troublesome, much less herding is necessary till 'rutting' time, November 22nd to December 31st, comes round, during which period the closest attention is again demanded. [W. B.]

Hirudinea, the tribe of the leeches. See LEECH.

Hive.—Hives are fully dealt with under the art. BEEHIVE.

Hoar Frost.—Hoar frost, familiarly called 'rime', is just frozen dew. Both rise from the ground; when the incumbent air is about the dew-point, the warmer air as it rises from the ground is seized by the air and forms dew; when the air is very cold, the moisture in the rising air is frozen and becomes hoar frost. One of the most interesting experiments, without apparatus, to be made is in connection with the formation of hoar frost, when there is no snow on the ground, in very cold weather. If it has been a bright, clear, sunny day in January, the effect can be better observed. Look over the garden, grass, and walks, on the morning after the intense cold of the night, and turning up the dead leaves, you will find a thick white coating of hoar frost, as thick as a layer of snow, on their *under* surface, while there is none on the upper surface. If snow has fallen, the hoar frost beautifully bedecks the trees. There is a *spurious* kind of hoar frost, which is attended with no cold whatever at settling upon bodies. Trees and buildings are apt to be decorated with it during a mist in frosty weather; in which case the hoar frost has been previously formed in the air, and floated in it, and was not formed in the act of being deposited upon the body. This is called 'rotten rime', and is much more injurious to the health of man and beast than the pure hoar frost. [J. G. M'P.]

Hoar Frost—Damage to Woodlands.—Hoar frost or rime is formed in place of dew when radiation of warmth reduces the temperature of plants below the freezing-point, so that the aqueous vapour contained in the air is deposited on them as ice crystals during the night time. When the atmosphere has been very damp the hoar frost may form a coating of ice upon twigs and branches. After this has taken place, if a snowstorm comes on, this icy coating enables the snow to settle in larger quantities on the branches and twigs, and on any foliage there is on the tree, and to weigh down or break off the branches. And if the rime thaws slightly and then freezes again, a thicker coat of ice is more likely to do damage by overweighting and tearing off the branches from young trees. The tree that suffers most in this manner is the rather brittle Scots Pine, and especially when forming pure woods in misty tracts. The only practicable way of lessening the danger of damage from hoar frost is to form mixed coniferous woods in place of pure crops of Scots Pine, and to have a good fringe of thickly foliaged trees (such as Spruces) along the exposed edges of the plantations. Properly thinned plantations and woods are less exposed to damage than crowded crops with comparatively weakly developed crowns. [J. N.]

Hock.—The hock corresponds to the ankle and heel in man. In the horse the joint consists of the following bones: the *astragalus*, the largest bone entering into its formation, possessing deep spiral grooves on its front face for articulation with the lower end of the *tibia*, or second thigh bone, forming therewith a hinge-like joint. The main articulation at the back of this bone is with the *os calcis*. The remaining bones are arranged in two rows: the *scaphoid* in the upper, whilst the *cuboid* and two cuneiform are in the lower row. The bones of the hock are commonly the seat of disease, such as spavin. In the ox only five bones are present, the scaphoid and the cuboid being combined; whilst in the dog and pig seven bones are present in the hock. [F. T. B.]

Hock, Sprung.—Sprung hock is a serious malady, requiring much time for recovery. Between and connecting the small bones of this joint are short ligaments (interosseous), and the annular ligament, surrounding the hock. If these or some of them are sprained, much swelling and pain follows, with a febrile condition, or sympathetic fever as it is still called. *Treatment* should include removal of the shoe, the use of slings to rest the animal, which fears to lie down, a ball of aloes, and laxative diet, warm fomentations, to which belladonna extract and glycerine may be added as anodynes, and later,

when the patient is able to rest without aid, a blister of biniodide of mercury 1 part, to lard 8 parts, after which he should have the greater part of a year's rest. [H. L.]

Hoes and Hoeing.—Hoes took a far more important place among farm tools and implements when drill husbandry was introduced. It is impossible to do satisfactory work with the horse hoe in broadcast crops, and hence hand hoeing has to be restorted to. The introduction of the turnip and root crops generally also greatly extended the area over which the hoe was necessary. Hoeing is done for two main purposes: to destroy weeds, and to keep a loose mulching of earth on the surface, so that moisture may be kept around the roots of plants, and not be dissipated by sun or wind, as occurs when the soil capillarity is continuous to the surface (see MULCHES). Irregular drilling necessitates a larger amount of hoeing and at the same time makes this operation slower and more difficult. The use of hoes of inferior type, both hand and horse, is responsible for less hoeing being done than otherwise would be. There are, in fact, counties of which it may be said that good hand hoeing is never performed; sometimes the stony nature of the land or its toughness has much to do with this, but these reasons are not in themselves sufficient to justify this neglect.

The Sussex hoe is merely a single- or double-end mattock, only fitted for chopping, and which it is practically impossible to use with a good pull-through stroke. The best hoes are those made with a swan neck with a bold sweeping curve, which allows the blade to be set at a proper pulling angle to the stale or handle. The mould and weeds will then fall over the top of the blade and will not block it. Hoes made with a short neck and eyelet, or with a short neck of any kind, are very liable to block with weeds or earth, as these readily accumulate between the hoe and the handle, making it impossible, except on the cleanest and loosest ground, to execute a long pull. With a good swan-neck hoe, a man accustomed to pulling through will easily take a 5-ft.-6-in. to 6-ft. stroke, whether in hoeing corn or flat-hoeing roots. He will then hoe from $\frac{3}{4}$ to 1 ac. per day of oats or barley on loose land, or $\frac{1}{2}$ ac. on very stiff wheat land hard set after winter, doing the work thoroughly and making each stroke join the preceding one. In hoeing roots the hand hoe is employed to hoe alongside the roots and leave only space for the root plants; to chop out all plants and weeds except those required to form a plant, braird, or crop; and a third operation, called seconding or singling. The plants left double previously are singled, and the interspace is cleaned of any weeds remaining. The work done by the hand hoes should be confined to a very narrow width, as the horse hoe should be worked very closely to the plant rows. On light fen soils where there are no stones, snatch hoeing is often done. The snatch hoe is made like a rake, but in place of the teeth three hoes are set into the slotted head, being made adjustable so as to adapt them to the width of the rows. The workman walks backwards snatching the hoe after him, and will hoe 3 ac. a day, making good work. Push hoes are sometimes used for cleaning wide rows, such as turnips, where the land is loose, doing the work which is ordinarily done by the horse hoe; they are useful in market-garden work, or in places where the rows are short, and where the horse in turning would do harm to the growing plants. Hoes with a double neck are, as a rule, inferior to those with a single neck, because weeds accumulate so readily in the neck; but on clean land with a fine surface they are not so objectionable, and excellent hoes for these conditions may be made from old chaff-cutter blades, as the steel keeps such a good cutting edge; at the same time a better hoe is made from a single swan neck. Ordinarily, double necks should be avoided.

Horse hoes do good work at small expense, and a well-made horse hoe, adaptable to suit all crops, is one of the most valuable implements on the farm. There are three types of horse hoe commonly used: (1) the single row, to work in root, potato, and bean crops, which is a small cultivator with adjustable hoes; (2) the steerage hoe, in which a number of tines are carried on a frame hooked on to a fore carriage, which is otherwise independent of it. As the frame is merely hooked to the fore carriage, and is provided with long steerage handles, the steering of the hoes is very easy; and as the pitch of the tines and hoes is easily altered, they can be set to do any work. On whatever land we have been, we have never found it convenient to be without one of the hoes, either for corn or root hoeing. Hoe blades to suit any work can be made, and we have always kept sets in sizes grading from 4 in. to 20 in. The large hoes are serviceable to work between root drills long after two or more small hoes can be used, as there is only one tine in the middle of the row, and this does not pull off the leaves. (3) The lever horse hoe is probably the most widely used horse hoe. In these the hoes are carried on coulter arms hinged to a front coulter bar, and carried beyond the point at which the hoes are attached, so that they may be weighted with adjustable weights to regulate the depth of stirring. They are fitted with attachments which render their control simple, but we prefer them for shallow work rather than for deep work. Certain makes of cultivators are fitted with a fore-wheel steerage which makes steering easy, and by fitting blades to the sickle tines a thoroughly efficient horse hoe is made. We think that the sickle tine will be much more generally used in horse work when its value for the purpose is recognized. The type of hoe used on horse hoes is important. We much prefer those of a V shape to those of an L shape, as the former naturally draw themselves into the ground, whereas the latter have to be pressed in, greatly adding to the draught; moreover, the L hoes have a much greater tendency to break off side rootlets.

[W. J. M.]

Hog Cholera, a contagious eruptive disease which affects pigs. See SWINE FEVER.

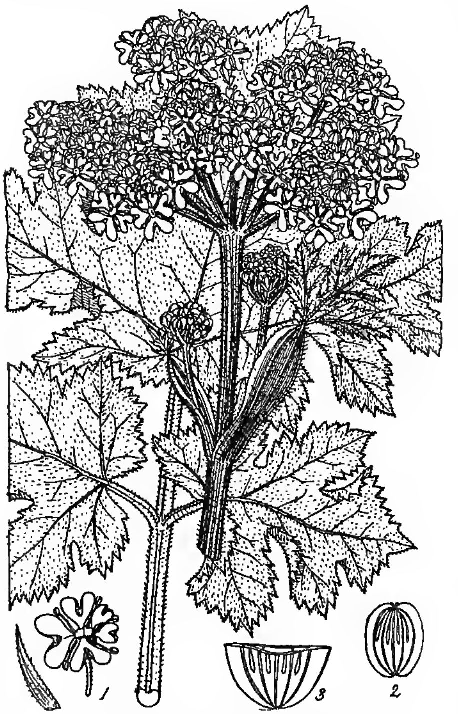
Hogg.—A young sheep from weaning time till the first clip is called a hogg. Hog is also a

general name for the pig; more particularly it is applied to a castrated boar.

Hogget.—A young sheep of either sex which, after weaning, is folded on to turnips for the winter is called a hogget. Hogget also means a boar in its second year.

Hog's Fennel, or **Sea Sulphurwort** (*Peucedanum officinale*), is a bald, perennial umbelliferous plant 2 or 3 ft. high, which is sometimes found growing in salt marshes. The umbels bear small sulphur-yellow flowers, and later oval fruits about $\frac{1}{4}$ in. long. The leaves are divided into fine linear segments about 2 in. long. [A. N. M'A.]

Hogweed, or **Cow Parsnip** (*Heracleum Sphondylium*), is one of the commonest umbelliferous plants in Britain. It is a coarse, hairy, biennial or perennial weed of moist meadows, pastures, and waste ground, readily recognized by its height (3 to 4 ft.), and by the large, broad segments of the leaf, with rough hairs. The fruit is also very characteristic; it splits into two very flat pieces (*mericarps*) about $\frac{1}{4}$ in. long, and almost as broad, each containing one seed. The seedcase is marked by the dark-coloured and club-shaped oil canals (*vittæ*), which do not extend to the base of the fruit (as in Parsnip), but reach only halfway.



Hogweed (*Heracleum Sphondylium*)

1, Flower and scale. 2, Fruit. 3, Cross section of single carpel

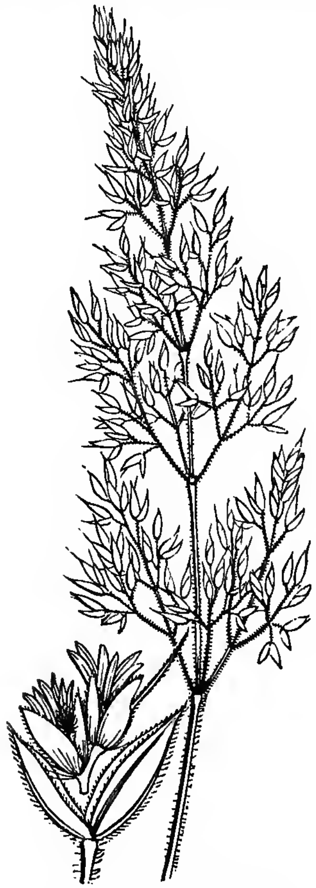
The flowers are white, sometimes with a tinge of pink, but never yellow like those of Parsnip. Hogweed, unlike most of its allies, is not at all poisonous, and has been used for feeding pigs. A gigantic species from Siberia (*Heracleum giganteum*), with annual stems from 10 to 15 ft. high, and umbels of white flowers more than 1 ft. broad, is often cultivated for ornament. [A. N. M'A.]

Holcus is the botanical name for a genus of perennial grasses, of which the commonest species is *Holcus lanatus*, well known as Yorkshire Fog, or Woolly Soft Grass. The plants are hairy weeds with soft leaves, and when the shoots are pulled up they show characteristic red veins in the white sheath of the leaf. The ear is branched like that of the common oat (*panicle ear*). The spikelets attached to the branches of the ear are flat and white-coloured, about $\frac{1}{6}$ in. in length. As shown in the figure, each spikelet contains two flowers, and for purposes of distinction from other grasses it should be noticed that the lower flower of the pair is constructed differently from the upper — the lower has no awn, the upper has; the lower is perfect, with carpels as well as stamens, whereas the upper is imperfect, with stamens only, and so is incapable of producing a grain, and of reproducing the plant. The species of Holcus are:—

1. Yorkshire Fog (*Holcus lanatus*), distinguished by the abundance of soft woolly hairs, by the tufted mode of growth, by the joints of the straw hairy all over, and by the awn, which is curved inwards like a fish hook, lying concealed within the husk of glumes. This perennial top grass forms large tufts of herbage, composed of a number of partial tufts, placed at different heights, but compacted together. Some of the erect, stout branches which form and bear the partial tufts are lengthened out, while others remain quite short, hence the inequality in height. These stout tuft-bearing branches above-ground interfere with the scythe and make cutting difficult. The leaves come out rather early, about the month of March. The herbage is not sensitive to frost, and the power of resisting drought is very great, owing to the dense hair covering. Accordingly, this troublesome weed thrives, especially on poor light land, and more particularly on moorland. A tuft of herbage produces many straws (*culms*), which reach a height of 2 or 3 ft. After cutting, the straws do not again form till next season, hence the aftermath is much less than the first cut. The panicle ear at the end of the straw is from 3 to 6 in. long, and the spikelets about $\frac{1}{6}$ in. long. When the ear is ripe, which it usually is early in July, the whole spikelet detaches from its stalk and forms the so-called 'seed'. Unless this seedmaking process is prevented, the plant will spread very rapidly. The wide distribution of Yorkshire Fog is readily explained by the exceeding lightness, hairiness, and flatness of the 'seed', which exposes a large surface to be caught by the wind. The sweepings of 'hay lofts' often contain much (50 per cent) Holcus seed, and these sweepings, of course, should neither be sown, nor mixed with the dung.

The precautions to be taken against Yorkshire Fog are: (1) The seeds sown, and more particularly the ryegrass seeds, should be pure, and free from Yorkshire Fog; (2) the plants should

be cut down to prevent seeding; (3) sweepings from hay lofts should neither be sown, nor mixed with the dung; and (4) large perennial top grasses, Tall Oat (the non-bulbous variety), for example, should be sown in preference to small sole grasses such as Perennial Rye Grass, because the large grasses can hold Yorkshire Fog in check much better than the small Rye Grass. Stock do not readily browse Yorkshire Fog, but when the snow lies deep on the ground, its herbage remains soft and unfrozen, and is readily taken by



Creeping Soft Grass (*Holcus mollis*)

sheep in preference to the other grasses, which are frozen and stiff.

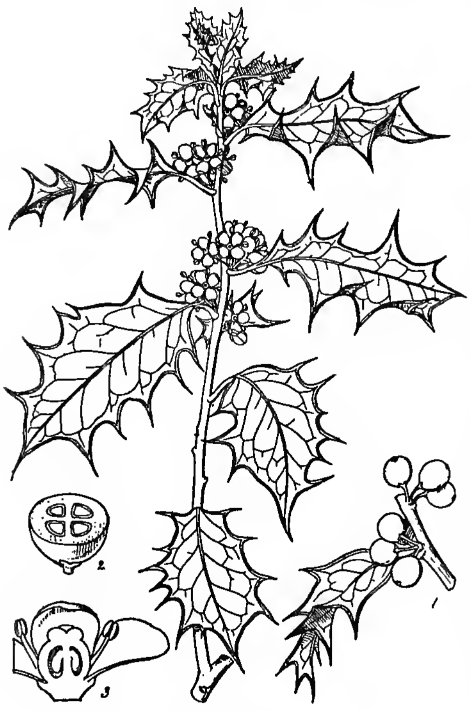
2. Creeping Soft Grass (*Holcus mollis*) is distinguished from the preceding species by the hair being more scanty, by the underground creeping mode of growth, so that the shoots stand separate and not in large tufts, by the joints of the straw having a downward sloping ring of hairs, and by the single straight awn projecting from the apex of the spikelet. This perennial weed of sandy land is refused by stock, and is quite useless to the farmer. It is, however, useful for fixing dry sandy banks and railway slopes, as its creeping underground stem extends very rapidly, 5 or 6 ft. in a single season. When this underground creeper has overrun land it is extremely difficult to eradicate. The creeping underground stems must be repeatedly removed by hand-picking, and the soil should be enriched so as to favour the growth of valuable grasses.

[A. N. M'A.]

Holderness Cattle, a breed of cattle of large frame, straight backs, long quarters, and clean straight legs, which had their home in the district north of the Humber, and to which the modern Shorthorn largely owes its origin. See Shorthorn Cattle.

Holly, or **Holm** (Ilex), is a genus of the family Ilicineæ, belonging to the nat. ord. Frangulineæ (to which also belong the Dogwoods, Spindlewoods, and Pimpernels). Various genera of the Ilicineæ are scattered throughout South Africa, the West Indies, and South America, while only a few are indigenous to Europe. The Maté, or Paraguay tea, is an important South American species. The genus Ilex consists mostly of evergreen shrubs and small trees chiefly indigenous to Central Europe and North America, and is characterized by having a 4–5-toothed permanent calyx, a 4–5-cleft, subrotate corolla, 4–5 stamens alternating with the segments of the corolla, a sessile ovary, 4 stigmas, and a berry containing 4–5 one-seeded nuts. There are several species (besides numerous varieties), some of which have spiny teeth on their leaves, while in others the leaf has a smooth edge. The Common Holly or Holm (*Ilex Aquifolium*), abundant in most of the old woodlands throughout the British Isles, and especially in central and southern England, is indigenous to the centre and south of Europe. It is characterized as a species by its shining, oblong, wavy, spiny-toothed leaves, its axillary peduncles of nearly umbellate white flowers appearing in May, and its bright-red berries ripening in September and remaining on the twigs throughout the winter. But while all the lower leaves are very spinous up to about the height to which cattle and goats can browse (and especially on old trees), those above that are entire—a peculiarity shown also to some extent by the Holm Oak (*i.e.* Holly Oak) and the Juniper. Bushes that have been browsed by cattle or goats, or that have been pruned, produce foliage with more and larger spines than those left in a true state of natural growth. In the woodlands Holly can endure a considerable degree of shade, and its dull greenish-white wood is hard, heavy, tough, and fine in texture, useful for inlaying and cabinetmaking when of any large size; but as it only attains the dimensions of a tree when growing in full exposure to light, stems of timber size seldom come on the market. Cultivated in the open it can attain a height of up to 60 ft., when the ornamental effect of its dark glossy evergreen foliage and its red clusters of berries throughout the winter is really of far greater value than its timber, even though large pieces fetch up to 6*s.* a cu. ft. for inlaying and cabinetmaking. It forms a good ornamental hedge, as it has strong reproductive power and well stands clipping and trimming. Along with the Yew it is therefore the shrub chiefly used in the oldfashioned 'topiary' gardening. Holly

attains a great age, and sometimes a large girth. One of the largest specimens in Britain, growing at Llanidloes (Montgomeryshire), has a girth of 30 ft., though its height is only 43 ft. Holly thrives best on a light, dry, humose loam, or on cool, fresh, loamy lime and sand, and (again like the Yew) does all the better when lime is present in the soil, as it then grows spontaneously and often thickly. Like the Hawthorn, its seed lies over till the second spring after ripening before it germinates; but if sown about sixteen months after ripening, it comes up during the course of the spring. It is of slow growth when young, and



Holly (*Ilex Aquifolium*)

1, Fruit. 2, Section of fruit. 3, Section of flower.

should therefore be kept for three years in the nursery lines before being planted in the open. Numerous garden varieties are cultivated by cuttings, the most common being one with white-and-yellow leaves (*I. A. variegatum*), another with very prickly leaves (*I. A. ferox*), and one with smooth, entire-edged foliage (*I. A. inerme*). [J. N.]

Hollyhock, the popular name for a race of plants raised from *Althea rosea*, a Chinese mallow, but cultivated in Europe for more than three centuries. Originally a tall, loose-growing plant with large single flowers, it has developed under cultivation and selection, and there is now a great range of variety in the form, size, and colours of the flowers. The most marked advance has been in the doubling of the flowers. Unfortunately the hollyhock is subject to the attacks of a fungoid disease (*Puccinia*) which is difficult to cope with. Spraying the plants with Bordeaux mixture acts as a preventive (see next art.). The single-flowered forms are raised from seeds, but the double varieties are increased either by division or grafting. Hollyhocks are excellent plants for gardens near the sea. [W. W.]

Hollyhock Rust.—Introduced into Britain about 1873, this disease has seriously interfered with the cultivation of hollyhock and other mallows. It appears as firm, rounded, brownish pustules scattered over the leaves and other parts. The pustules are masses of teleutospores of *Puccinia malvacearum*, a rust-fungus; at present no other form of spore is known. *Treatment.*—Careful collection and burning of diseased leaves and stems, and the rejection of rusted fruit-heads, are stated to have prevented the reappearance of rust. The following are some recipes recommended by growers:—(*a*) Spray-fluid of permanganate of potash or Condy's fluid, made up with water to a rose-red colour; (*b*) sulphonaphthol, a liquid added to water at rate of 1 tablespoonful in 1 pail, and used as a spray-fluid; (*c*) to 1 lb. tobacco powder add ¼ oz. finely powdered sulphate of copper, mix well and dust the foliage thoroughly at intervals of two or three weeks. Several other leaf-spotting fungi recorded on hollyhock may be kept in check by similar treatment. [W. G. S.]

Holm, a term of Norse origin often applied to islands, but also used for the alluvial stretches along river-sides or on lands formed by delta-deposits on sea-shores. Romney Marsh has thus been styled a holm, and the word is in common use in Scotland and northern England. See art. ALLUVIUM. [G. A. J. C.]

Holstein Cattle. See FRIESIAN CATTLE.

Holstein Horse.—The district in which the Holstein horse is chiefly encouraged extends from the Eider river to Wedel, near Hamburg, this neighbourhood having been the stronghold of the breed for upwards of a hundred years. The chief supporters of the variety in the olden days were, singularly enough, the clergy of the country, who were far-seeing and patriotic enough to recognize the fact that the horses the neighbourhood possessed required improvement, and therefore imported Oriental sires for the purpose, thus following the example set them by British breeders. So successful were these crosses that the fame of the Holstein horse soon spread, the result being that it is stated that in the year 1780 the Duke Frederic Augustus imported stallions of this breed into the Oldenburg district with the object of benefiting the horses there. It is also recorded that the French military authorities obtained large numbers of their cavalry remounts from the breeders of Holsteins about the year 1820, thus proving that the race was well established at the time.

As is the case with most of the leading Continental breeds, the Holstein horse owes much to the care with which his best interests are fostered by a society. The institution in this instance is known as the Union of Horse-breeders in the Holstein marshes, which came into existence in the year 1897, when it absorbed a former society founded in 1883, and considerably extended its basis of operations. A result of this

is that a stud book of the breed is now published under Government supervision, and in this volume only the best stallions and mares are allowed to be entered, these must, moreover, be absolutely sound, indeed no unsound stallion is permitted to serve mares in the district. In spite of these restrictions, however, the names of upwards of two thousand stallions and five thousand mares appear in the stud book, a circumstance which proves the success that has attended the regulations of the Union of Breeders.

The latter, moreover, have erected a very extensive and costly riding school at their headquarters, with the laudable object of instructing Holstein breeders how to break and manage their horses. This establishment is subsidized by Government, and has accomplished a great deal of good; but the services rendered to the breeders of the district do not end here, as there is a regular selling department in existence in connection with it, and this enables the owners who desire to sell their horses to dispose of them under very favourable conditions.

So far as his appearance goes, the Holstein horse somewhat resembles the Hackney, whose blood has doubtless entered into his composition at one time or another. The resemblance, however, is stronger in the case of the mares than the stallions, as the type of the latter which is preferred is somewhat lighter than that of the English horse; but the quality which is present is not procured at the expense of substance, for the Holstein possesses his share of bone. His action is very good, though not equal to that of the Hackney so far as its height and dash are concerned; but he is unquestionably a very valuable harness horse, and possesses admirers in every part of the world. [V. S.]

Holy Grass (*Hierochloë borealis*) is an ally of Sweet Vernal Grass, and like it emits a strong fragrant odour of new-mown hay; in both cases this odour is due to the presence of the substance known as *cumarin*. Like Sweet Vernal also, Holy Grass is useless for agricultural purposes, as stock refuse it. It is a low grass, distinguished by its fragrance, by its underground creeping habit of growth, by its panicle ear, and by the flat spikelets, each containing three flowers, two of which are barren. In Britain, Holy Grass has been found only at Thurso, growing on a little island in the river there, but it is common on wet light land in mountain pastures of northern Europe, Asia, New Zealand, and America. In some parts of Europe the herbage is strewn before the doors of churches on festival days, hence the name Holy Grass. [A. N. M'A.]

Home Farm.—The home farm is now a less important institution than it was in the past. It used to be an object lesson in improved methods of agriculture to the farmers in its immediate neighbourhood. Nowadays, however, the tenant farmer, instead of seeking to profit from the teaching which a well-managed home farm can impart, is inclined to sneer at the want of proper economy which characterizes the various practices there carried out. But one can hardly expect to see such strict economy observed at the home farm as at the other. So long as the men are not allowed to 'slack' unduly and thus set a bad example to those on the adjoining farms, affairs generally may be allowed to proceed in a less intensive and more leisurely manner than one would expect at a rent-paying farm.

Besides being less important from a public point of view than it was, the home farm is becoming less common than it used to be. This is unfortunate in a way. The letting of the home farm which is now so prevalent a practice is no doubt largely due to the agricultural depression of late years. When rents began to fall and the expenses of its upkeep tended to increase, the home farm became an expensive hobby that few landlords could continue. Many, no doubt, were glad of any excuse to get rid of it. And so the squire of to-day is less familiar with agricultural practice than either his father or grandfather was. This is unfortunate, because nothing brings landlord and tenant into closer relationship than for the former to do a little farming on his own account.

The British home farm has always been the home of the best specimens of those breeds of live stock for which our country is justly famous. Before the farmer had any idea of an outlet abroad for picked specimens of his stock, he looked to the home farm for a market for such. In this way alone did the home farm prove of benefit to agriculture at large. Not only did the owner of the home farm thus encourage the breeding of improved stock; he bred them himself. When farming was backward the tenants in the neighbourhood of an enlightened landlord of this sort received the benefit derivable from the use of improved sires. If no breed of British live stock can be said to have originated on a home farm, at any rate prominent families of many of them have been raised on a farm of this description. And the thoroughbred, we may observe, is almost peculiar to the home farms of England. [R. H.]

Homestead. — For a description of the homestead, the reader is referred to the art. BUILDINGS, FARM.

Homing.—Homing is the name applied to the habit which some pigeons and other birds possess, of returning to their homes, when let loose in another locality. They can thus be used for the purpose of carrying messages to the places where they were reared. The typical Homing Pigeon resembles in shape the Blue Rock Pigeon, and has very powerful wings. During the siege of Paris, a regular pigeon post was established, by means of which communication with the outer world was kept up. The messages should be written on very small pieces of paper, and either wound round the shank of the leg, and gummed there, or else rolled into a cylinder, and attached to the quill of one of the tail feathers. In training, the pigeons should at first be let out about 500 yd. from the loft. On successive days they should be taken in different directions. When they are accustomed to these short journeys, they may be taken a

mile or two away, then several miles off, and so on, till great distances are reached. When being trained, they should be fairly hungry before taking a flight, so as to ensure their going straight to the loft for food. [H. S. R. E.]

Honesty, an ornamental cruciferous plant commonly grown in gardens for decoration purposes. See LUNARIA.

Honey.—Honey is produced from the nectar which bees and other insects gather from the various kinds of flowers; and when in quest of the honey insects perform a most important function in the fertilization of flowers. A warm day succeeded by a close dewy night is the best kind of weather for producing it, and beekeepers should then be specially on the alert for securing crops of good honey. The nectar undergoes a certain definite change in the honey sac of the bee, and it is also held that the bees add a trace of formic acid before final sealing up. The principal kinds of honey may be classified as follows: (*a*) Flower honey, gathered from clover, sainfoin, blossoms, &c.; (*b*) heather honey, from ling, heather, heaths, &c.; (*c*) granulated honey, either flower or heather solidified. There are, of course, mixtures of (*a*) and (*b*), and it should be noted that good granulation is a test of purity. Flower honey is almost clear, with a tinge of yellow; heather honey dark amber; and granulated, tallow-like. The finest qualities of flower honey are from Dutch clover, sainfoin, raspberry bloom, &c. Hillside heather usually gives thick creamy honey; granulated is gritty and sweet. The difference between flower and heather honey is analogous to that between chicken and grouse. The principal points in run or extracted honey are: (1) flavour, (2) consistency, (3) colour, cleanliness, get-up, &c.; and in comb honey: (1) regularity of comb; (2) completeness of finish; (3) flavour and consistency, colour, &c. In preparing honey for exhibition or sale, beemen should pay the utmost attention to these points. The most marketable sizes of honey are 1 lb. jars of clear glass, with screw tops lined with cork, for run honey; and 1 lb. sections, $4\frac{1}{4} \times 4\frac{1}{4} \times 2$ in., for comb honey. Larger jars, and sections, and big supers, are not so easily sold, or handled by the purchasers. When the sections are taken off the hive, they should be carefully scraped and cleaned, and graded by points as above, into first, second, and third qualities; one poor section will bring down the price of a lot. In the same way, the run honey should be classified, and then closed up in the jars; a little wax on the cork inside the screw cap will prevent leakage. During storage, all honeys should be kept in a dry room of equable temperature. Metal or cardboard cases enhance the appearance of the sections; and nice labels the bottles. Section travelling crates should have springs at top and bottom; and jars require corrugated paper packing. [R. M'C.]

Honey-dew, a sweet sugary exudation that often makes its appearance on the leaves and small twigs of many trees or shrubs in summer, and in most cases is due to the secretion from the cornicles of the aphides. There is a stage in the development of the fungus ergot in which a sweet, slightly milky juice, popularly called 'honey-dew', is secreted. See the description of ergot under the heading RYE — PARASITIC FUNGI.

Honeysuckle.—The fragrant honeysuckle is described under its botanical designation Lonicera. See LONICERA.

Hooded Crow (*Corvus cornix*). See CROW.

Hoof.—The anatomy of the hoof is treated under the heading FOOT, ANATOMY OF, to which reference should be made.

Hoof Manure. — The horny part of the hoofs of various animals is ground up into a fine dust, and as such is used as a manure. See NITROGENOUS ORGANIC MANURES.

Hooks. — Hooks are used for several purposes on the farm: the most common is the short-handled hook, known variously as the short hook, fagging-, bagging-, bean-, swish-, brushing-hook, or swap. Before reaping machines came into common use, the short hook was extensively used for cutting (fagging or bagging) corn crops, and is still used for cutting beans that pod very closely to the ground. It is almost exclusively used for cutting turnip seed and similar crops. The sickle is a hook made with a serrated edge, and is used for reaping corn, when a handful of corn is held in one hand, away from the body, and practically sawed off by a pulling stroke taken below the hand. Other hooks have plain edges, and cutting is done by a sharp stroke. The short hook is also used for trimming growth from ditches, and brushing or trimming hedges. Occasionally a short hook is used for cutting peas; but in the chief pea-growing districts a long-handled hook is most commonly used, and is most convenient, especially with long-straw varieties, as it is better suited to pull out the long haulm, which may spread several feet from the root and become much entangled. The long-handled hook is much the best for trimming hedges, as it is not only more expeditious, but much more power can be put into the stroke, and harder growths cut through. Hedges always trimmed with a short hook are liable to become top heavy, because it does not do more than cut the new growth. A short hook without a cutting edge is often used for collecting sheaves to be bound when cut by a self-delivery machine. Pot hooks are used for suspending kettles over fires, and for holding baskets when gathering tree fruit. [W. J. M.]

Hoose, or **Husk,** frequently occurs in calves and lambs, and causes among them a considerable mortality.

Causes.—A worm known as *Strongylus micrurus*, present in the bronchial tubes and air passages. In wet seasons this affection breaks out, especially on low badly drained lands, which are liable to be flooded. It occurs particularly among calves which have been kept out late in the autumn, and as a result of feeding on land on which animals suffering from this disease have been previously grazing.

Symptoms.—A cough, which is very forcible and has a special hacking character; the expulsion of stringy mucus, in which parasites or

their ova may be found. The animals become emaciated, and there may be diarrhœa.

Treatment.—Isolate the affected animals, and put the healthy ones on fresh pastures. Strew the contaminated pasture with fresh salt or lime. The diseased animals may be treated in a variety of ways. Fumigation with the gas given off from burning sulphur has been recommended, but this treatment should be cautiously adopted.

Give to each animal once a day fasting: Oil of turpentine, 1 part; linseed oil, 9 parts. Or, by injection into the windpipe, one or two doses of iodine and chloroform and carbolic acid. This treatment is now very generally adopted.

The cause of verminous bronchitis in sheep is another Strongyle worm, but this parasite is more often the cause of pneumonia. Similar measures may be adopted for the treatment as in the case of calves.

In the case of dogs the affection is chiefly confined to puppies, and in many instances the windpipes have, on post-mortem examination, been found completely blocked up with worms, surrounded with a frothy fluid. Naturally the youngest dogs, as having the least resisting power, are those which succumb to the parasites.

Treatment by stimulant tonics and such measures as are resorted to for cases of hoose in cattle—an exact pathological equivalent of the disease in dogs. Therefore the intra-tracheal injection method of administration may be tried.

[H. L.]

Hoove, a condition of the rumen or paunch when distended by gases. See Blown or Hoven.

Hop.—The hop is indigenous to most parts of Europe, but though known as a wild plant in this country, it was some time before it was considered by agriculturists to be a profitable crop to grow; in the eyes of many it was regarded (and actually petitioned against in Henry VI.'s reign) as a wicked weed, and shared this estimation with many other plants which are now cultivated (certainly in an improved form) for economic use. The English word *hop* was adopted into our language from the Dutch *hop*, *hoppe*, a word of doubtful root. The botanical name is *Humulus Lupulus.* The cultivation of the hop was introduced into this country from Flanders in 1524, in the fifteenth year of the reign of Henry VIII, and hops were first propagated in Kent, Essex, and Surrey; they were next cultivated in the south and west parts of England and in Nottinghamshire. The first mention of them in our statute books occurs in 1552, Edward VI, c. 2, and the earliest known account of their culture appears among some ancient French records of King Pepin's time, in which *humolariæ* (hop gardens) are mentioned; but Beckmann states that the first positive notice of the use of hops occurs in the beginning of the 14th century, when it appears that they began to be regularly employed in the breweries of the Netherlands.

In many of the old herbals, considerable space is devoted to hops and their medicinal and prophylactic value in the cure of disorders of the blood and digestive organs, and of diseases or ailments of the ear, and their value seemed much appreciated. Whilst, however, their efficacy was admitted and the virtues of hops were described, in that they gave flavour and strength to the malt liquors, and were able to make them keep for as long a time as was desired, they were also supposed to contain qualities noxious to the constitution, among which it was said that they 'dried up the body and increased melancholy', and accordingly we find in the regulation of Henry VIII an order to the brewer not to put any hops in the ale; and if the portraits we have of his uxorious majesty are faithful, and the character he bears is true, neither a dried-up body nor a melancholy temperament were his characteristics. Fitzherbert, in 1534, makes no mention of hops. Tusser (1562) gives minute directions for their culture in his curious rhymed lines. Reynold Scot (1576), in his Perfite Platforme of a Hoppe Garden, goes thoroughly into the matters of cultivation and general management, and speaks of the chief virtue of the hop as centred in the seed, and adds that 'hereof I cannot warn you too often or too earnestly'. Gerarde and Parkinson, herbalists (1640), mention the great improvement wrought in ale by the addition of hops, 'being rendered much more healthfull or rather physicall'; and Walter Blith (1649), in the English Improver Improved, refers to the cultivation of hop plantations, and mentions that hops were then grown as a national commodity, but that it was not many years before that the City of London petitioned the Parliament against two nuisances: Newcastle coals with regard to their stench, and hops 'in that they would spoyl the taste of drink and endanger the people; and had the Parliament been no wiser than they, we had been in a measure pined and in a great measure starved, which is just answerable to the principles of those men who cry down all devices or ingenious discoveries as projects, and thereby stifle and choke improvements'. Ale brewed from malt only was of course known from much earlier time, as many records show, its origin belonging to an unknown past. Alehoof, wormwood, broom, horehound, gentian, and ground ivy were used to make malt liquors keep, but they 'wanted strength to make the liquors keep or made them very disagreeable to the taste'. An old distich runs:

> Turkies, carps, hoppes, piccarell and beere,

or in another,

> Hops, reformation, bays, and beer,
> Came into England all in one year.

To continue our historical survey, Hartlib, in his Compleat Husbandman (1659), states that England had hops from the Low Country, but that English hops were of a much superior quality. Worlidge, in his Systema Agriculturæ, or Mystery of Husbandry Discovered (1669), gives minute directions as to the cultivation of the hop, and Mortimer, in the Whole Art of Husbandry (1707), also states fully the management of hop gardens and the uses of the hop. Bradley, in The Riches of a Hop Garden Explained (1729), gives rules for the management of

the hop 'as may improve the most barren ground from one shilling to thirty or forty pounds an acre per annum', and in his instructions for planting and managing hops (1733), goes most fully into the best methods of cultivation, and of methods of raising hop poles.

This short historical review of hop growing will be sufficient to show the position hop growing took in the arts of agriculture, and that considerable attention was devoted to it as an industry, in the words of Bradley, 'considering the small space of ground the plant takes up in comparison to other plants, and the small expense of planting, the prodigious profit to the proportion, and the great advantage it brings to the Crown of Great Britain'.

There seemed to be, according to Lance (The Hop Farmer, 1833), a considerable importation of hops into England until 1693, by which time the culture in Kent was well established, and in 1710, by an Act of Queen Anne, a duty of 3*d.* per lb. was laid on all hops imported. In George II.'s reign (1734) we find a duty of 1*d.* per lb. levied on all hops grown in England and made fit for use, payable within six months of being cured and bagged, and hop grounds were required to be entered in the books of the Excise authorities, under a penalty of 40*s.* per acre; all places for curing and keeping were to be registered, and hops must be cured within six weeks of picking, under a penalty of 5*s.* in the pound. Many other penalties were enacted: for rebagging foreign hops in British bags for exportation; against brewers using any bitter ingredients except hops; against the use of any but English hops in Ireland; against mixing any drug so as to alter the natural colour or scent; against unlawful and malicious cutting of hop bines, &c.

The old duty of 1$\frac{3}{5}$*d.* per lb. on home-grown hops was increased in 1802 to 12*s.* 7*d.* per cwt., and reduced in 1805 to 4*s.* 8*d.*, and the duty on hops imported was £8, 10*s.* per cwt. The large amount of capital involved and the varying produce of the crop according to the season make the industry even now a speculative one, but these duties added to its speculative character, and before the duty was declared a very considerable amount of gambling took place.

The amounts received from the hop home duties varied considerably; in 1725 it is returned at £6526, and in 1826 at £468,410.

The duty was abolished in the middle of the 19th century, and the fluctuations of the industry have not appreciably altered since its abolition.

The acreage under cultivation is returned in 1807 as 38,218, and (with some fluctuations) there is a rise to 53,816 ac. in 1835, and to 66,703 ac. in 1880; in 1878 we find 71,789 ac. devoted to hops, but in 1905 the average is reduced to 48,967, and to 44,938 ac. in 1907, and it is probable that owing to the depression the acreage will be further reduced to 40,000 ac. in 1908.

There is no agricultural crop which fluctuates in yield so greatly from year to year as hops—in 1879, 71,789 ac. produced 700,000 cwt., which yield was obtained in 1905 from 48,962 ac., whilst the fluctuations in price are equally violent, varying from £2 to £23 per cwt.

The following figures demonstrate some important statistics with regard to the industry:—

Table I.—Acreage in Hop-growing Counties of England (1907)

Kent	28,169
Hereford	6,143
Sussex	4,243
Worcester	3,622
Hants	1,842
Surrey	744

Table II.—Acreage and Yield (*England*)

	Average annual acreage.	Average yield per acre.	Average annual home production.
		cwt.	cwt.
1888–1897 ...	56,370	7·76	438,215
1898–1907 ...	48,841	8·84	434,567

The total annual consumption of hops in this country may be taken at about 600,000 cwt., and the foreign imports are shown in the following figures:—

Table III.—Production of Hops in each County (1904–8)

County.	1904.	1905.	1906.	1907.	1908.
	cwt.	cwt.	cwt.	cwt.	cwt.
Kent: East	74,878	135,945	46,236	63,663	84,469
Mid	82,795	152,044	50,152	64,489	118,003
Weald	59,134	155,481	70,243	93,708	108,843
Total Kent	216,807	443,470	166,631	221,860	311,315
Gloucester	23	561	26	242	221
Hants	9,137	30,207	10,263	17,865	21,176
Hereford	14,101	88,802	24,953	58,268	54,554
Salop	280	1,626	442	910	1,015
Suffolk	5	9	11	—	—
Surrey	2,515	10,248	3,399	7,089	8,021
Sussex	27,726	69,059	22,070	39,679	40,203
Worcester	11,736	51,961	17,893	28,216	34,256
Total	282,330	695,943	245,688	374,129	470,761

Table IV.—Statement of Prices paid on the Worcester market to the grower by merchants in the four months September to December in each year from 1904–1907. (Extracted from Table XIV of Appendix No 1 to the Report of the Select Committee on the Hop Industry, 1908)

Year.	Price per cwt.
	s. s.
1904	160 to 195
1905	30 ,, 50
1906	90 ,, 110
1907	50 ,, 70

Table V.—Estimated Average Market Prices per cwt., September to December. (Extracted from Table No. 2 of Appendix No. 2 to the Report of the Select Committee on the Hop Industry, 1908)

Year.	Mid and East.	Weald.	Sussex.
	s.	s.	s.
1904	175	165	160
1905	50	40	40
1906	115	100	95
1907	80	65	60

Authority for prices: Messrs. Wigan, Richardson & Co.

Table VI.—Maximum and Minimum Weekly Average Prices per cwt. of Hops at London Borough Market from the week ending 17*th September to the week ending* 31*st December*, 1908. (Compiled from the Board's weekly return of market prices)

	Maximum.		Minimum.	
	s.	d.	s.	d.
East and Mid Kents	85	0	22	6
Weald of Kents	75	0	20	0
Sussex	60	0	16	0
Farnhams	85	0	21	6
Worcesters	92	6	22	6

Table VII

	Average annual imports.
	cwt.
1857–66	79,992
1867–76	202,537
1877–86	215,219
1887–96	194,966
1897–1906	186,362

The chief countries from which hops are exported to England are shown below for 1906 and 1907:—

	1906. cwt.		1907. cwt.
United States ...	126,982	...	126,142
Germany	68,059	......	52,362
Belgium	26,991	......	15,065
Netherlands	4,048	......	1,821
Austria-Hungary ...	3,017	......	2,987
France	1,056	......	730
Russia	372	......	3

The countries other than England in which hop growing is carried on are Germany, Austria, Hungary, France, Holland, Belgium, Russia, United States, and Australasia. The finest hops are grown in the Saaz district of Bohemia, and these command the highest prices in the world's market. British imports are mainly from Germany and the United States (see Table), but the conditions under which hops are grown in these two countries are essentially different. In Germany (where the hop plantations are of small area, as a rule) there is no effort made to push the crop for a heavy yield, and a yield of from 6 to 8 cwt. per acre is considered a good return; owing to the absence of mould and serious insect attacks, there is not much expenditure incurred in combating these pests, and the cost of getting the crop is comparatively small. The green hops are partly air-dried by the growers, and the merchants finish the drying process in kilns. In the United States the system is more comparable with our own. Large areas are the rule, and the most up-to-date methods in cultivation and securing the crop are used, but the cost is not as great as in this country. Both Germany and America are secured from foreign competition in their own markets by an import duty on hops.

Practically one-half of the importation of foreign hops into this country takes place from the United States; and the production in that country is restricted to districts in Oregon, California, New York, and Washington; comparatively small amounts are also raised in Idaho, Kentucky, Massachusetts, Michigan, Ohio, Pennsylvania, and Vermont, and it is in the Pacific States where the chief concentration of the industry now exists. The increase in American hop growing has been rapid; in 1849 we find 31,223 cwt. produced; 1869, 227,294 cwt.; 1889, 349,741 cwt.; and 1907, 545,643 cwt.; and the increase in American exports has also advanced considerably, more than 90 per cent of these exports coming to this country. It follows, therefore, that the fluctuations in the trade are dependent upon the production of the two countries in any one season, a shortage of our crop tending to increase American exports and to keep down prices, and in the event of a heavy American yield the surplus is dumped in this country (as was done in the early part of 1900 and in some subsequent years) at prices with which the English grower cannot possibly compete. Another point with regard to American exports is worth noting, and that is, that a considerable proportion is marketed in Australia, Canada, and British India, so that it may be said the American hop export trade is dependent upon our Imperial markets, and the brewers in this country are adapting their methods to the use of these larger-sized seeded hops for which there is little demand in German breweries.

It would be out of place here to go into all the details of cultivation and management of the crop; readers who wish such details may consult the article 'Hop Cultivation' in the Journal of the Royal Agricultural Society (1893), pp. 217 *et seq.*, where a full account of the industry will be found. Here will be given merely the outlines of the system, different aspects of which may be seen in the various districts in which hop growing is carried on. See also the art. HOP-GROWING MACHINERY below.

In early times there were two varieties of hops specified: the wild hop and the cultivated hop. Bradley states that these so-called varieties are really one, the larger-sized leaf and improved fruiting power of the tame hop being due to cultivating and manuring.

The existing varieties of the hop have been fully described by Professor J. Percival, Director of the Agricultural Department, University College, Reading, in the Journal of the Royal Agricultural Society (1901), pp. 67–95, of which article the following notes are a digest. Only two distinct varieties are known—the Japanese hop and the ordinary hop; the former is of no brewing value. The characteristics of a good hop are: (1) large yield, and should hang well when ripe without going off; (2) hardiness, resistance to mould and aphides; (3) high lupulin content. The varieties may be divided into Earlies, and Mid-season, and Lates. Amongst the former are Hobbs Early, Prolific, Meopham, Henham Jones, Bramling, White's Early, Early Bird. Some of these (notably Prolifics and the varieties including this type) are coarse, low-quality hops; Bramling, White's, and Early Bird are of fine quality. The mid-season varieties comprise Mercers, Rodmersham, Cobbs, Canterbury Whitebine, Cooper's White, Fuggles, Old Jones, Goldings (a general term to denote the Whitebines). The late varieties include the Grape, Mayfield Grape, Bates Brewer, Bass Hop, Colgates. It is, of course, not desirable to have all the hops in a garden of one class of maturation, or picking must either commence before some are ripe or extend to the time when some are going off; a good early and a mid-season variety should be planted, with perhaps a small area of lates to finish off the picking season.

The methods of propagation of the hop are by seeds or cuttings (setts). The hop is a perennial diœcious plant, but instances have occurred where both male and female flowers are borne on the same plant. The female blossoms are utilized in brewing, and they are seeded or not, according to the presence or absence of the male plant. Some difference of opinion exists as to the relative brewing values of the seeded and seedless hop, but there appears to be no definite evidence as to the brewing value of the hop being diminished by the fact of it being seeded. From the grower's point of view it would appear, from the work of Messrs. Howard, Salmon, and Amos (South-Eastern Agricultural College Journal, and Report of Hop Conference, 1907), that fertilization and consequent seeding of the hop has great advantages, in that it causes the hop to be less liable to attack of mould, and also to grow out better and give a greater weight per acre. In Germany there is a superstition, which is not sustained by any definite facts, that the brewing value is diminished by seeding, and in Bavaria male hops are ruthlessly extirpated from the gardens and their neighbourhood. The propagation of hops from seed is a method of raising new varieties; but as the variety of the male plant is generally not able to be ascertained, this method of propagation is not satisfactory, as so much is left to chance, and the production of a new and useful variety is somewhat problematical. There is no doubt that the creation of a variety with the brewing characteristics of the Golding, the productivity of the Fuggle, and a resistance to mould would be of immense value to the grower.

The new varieties that have been introduced in the last twenty or thirty years were generally obtained by a chance selection—when a plant of unusual vigour or earliness or other satisfactory characteristic is noted in a garden, cuttings or setts are taken from it and propagation so takes place.

Hops

The setts are taken in March and planted out, and the following winter they are transferred to the garden where they are to be grown—one set being placed in each hole, which is made 18 in. square—the distance apart of the hills or places in which the setts are planted varying from 6 to 8 ft. As a general rule, the wider the alleys or rows in which the hops are planted the less the crop per acre, but the better the quality, as sun and air have freer access and there is less danger of 'housing'.

Hops flourish best on the deep soils of a clayey, calcareous, loamy character, with an open marly subsoil, not liable to severe drought—the position should not be subject to late frosts, and must be protected from strong winds. The hop is principally cultivated in England between the two great chalk basins of the Isle of Wight and London, also in Hereford and Worcester, on the old red sandstone and red marls mixed with sands or limestone. When the garden is started, deep cultivation is a necessary preliminary so as to afford a good depth of staple to which the roots may ramify, and cultivations are adapted to secure the formation of a deep, easily worked

soil, so as to keep the plant always in a healthy state of growth.

Systems of training may be divided into two classes: poles which are set up and taken down each year, and permanent poles and wire with strings renewed each year. The former system entails less capital and perhaps less labour in training, but the latter system is more generally adopted on account of its affording more light and air to the plants, less labour at picking time, and generally an increased crop per acre.

The cost of establishing a permanent poles-and-wire system is from £50 to £60 per acre, and the annual repair on such wirework may be from £1 to £1, 10*s.* per acre. When this annual charge, together with the interest charge on capital expenditure, is put against the cost of setting up, taking down and stacking, with renewals of the pole system, it is found to be a considerable saving of expense, and the wirework may be regarded as a permanent equipment and improvement of the farm, for which compensation can be claimed under the Agricultural Holdings Act (1900).

The system of training hops on a slanting wire was introduced some thirty years back into this country by Mr. Butcher, but for many years it had already been utilized in some of the German hop-growing districts. In this system the poles, 12–13 ft. high, are placed in the rows of the hop plants or hills, about 20 ft. apart. Two wires are carried along these rows of poles both in the lines of the hills, one at the top of the poles and another, the breast wire, about 5 ft. from the ground. In each hill is placed a stump, and from this two or three Manila cords or 'strings' are led to the breast wire immediately above the hill and then slanted to the top wire in the next row of poles. The aspect of the slanting string is chosen to catch the most sunshine, and to avoid the effect of strong wind, a len row or hedge is planted round the garden, which shelter is supplemented by the erection of a 'len cloth', consisting of coarse cloth attached to poles. The habit of the hop is to grow straight up, hence when trained at an angle of 45 degrees it requires a considerable amount of training to keep it on the strings, and especially during strong winds, when the hops are liable to be blown off the wires, is the expenditure on training a serious item.

As to manuring, the hop is an all-round feeder, and requires to be supplied with all the elements of plant food in a suitable condition. The basis of hop manuring must be a bulky, organic manure, dung, high-class shoddies, or materials of that description, supplemented by soluble phosphatic and nitrogenous manures during or just before the time of active growth, and in the case of soils of a sandy nature, some potassic dressing, and when lime is deficient, a dressing of lime, ground lime, or chalk should be applied. It must be remembered in manuring hops that there is a very considerable amount of growth to be made, and that owing to the cutting and removal of the bine at the end, a great amount of the organic matter manufactured by the plant is not returned to the soil. Frequent cultivation is necessary in the growing season, the ground must be often stirred and aerated, and active healthy growth promoted throughout. A check to the plant through defect of cultivation may mean a weakening of the growth, and therefore a greater susceptibility to an attack by 'fly' or mould, which will be far more damaging in its effects on an unhealthy plant than on one which is in a sound state of active growth. The heavy manuring of hops which is generally practised conduces naturally to a very luxuriant growth, and thus renders the plant more delicate and liable to fungus attack than a plant grown under more 'natural' conditions.

The two chief evils to which the hop plant is subject are the aphis and the mould, but there are other enemies: wireworms, jumpers, red spider, and hop flea, which all have to be guarded against, and which in different seasons attain different degrees of virulence. Washing with soft soap as a basis, with the addition of quassia, is a remedy and preventive of insect attack. The soap should be added to the water in sufficient quantity to make a permanent lather (from 4 to 10 lb. is usually sufficient, but in a very hard water the larger quantity must if necessary be exceeded), and from 8 to 10 lb. of quassia to 100 gal. of water. This is sprayed on to the plants by hand or horse labour, care being taken to thoroughly wash both surfaces of the leaves. To destroy wireworm, traps of mangel-wurzel are placed about the garden, and these are collected occasionally and the pests destroyed. Beneficial insects such as the larvæ of the lady-bird (Niggers) and of the lace wing fly should be encouraged, as these prey upon the aphis and may greatly reduce their numbers.

To combat the mildew, sulphur is used, and this in the form of flowers of sulphur is either blown on to the plant by means of bellows worked by horse labour, or applied in the form of sulphide of calcium (liver of sulphur) as a spray. The former method is in more general use, and is generally carried out when the leaf is wet with the dew, so that the sulphur adheres to the leaves. See art. Hop-growing Machinery.

Hops are picked when the cones change colour from a greenish-yellow to a somewhat deeper shade of yellow, and when the tips of the cones close and 'rustle' when touched. The ripening and 'going off' or turning brown stage is difficult to hit, and picking is therefore generally done before a decided change in colour takes place, as the 'going off' is very rapid when it once commences, and a very rapid deterioration in quality results. The hops are generally picked by more or less unskilled labour from the towns, and the price paid per bushel depends upon the character of the crop—a light crop costing more to pick per bushel than a heavy one.

The curing or drying process is of great importance, as by careless procedure at this stage the value of the crop may be greatly depreciated. The object of the drying is to remove the greater part of the water which is contained in the green hop; but too rapid drying or the use of too high a temperature in drying may result in the valuable aromatic constituents of the hop being driven off, and changes induced in the other constituents which result in an unsatisfactory

flavour being imparted to them. The other extreme—slack drying—yields a hop that will not keep satisfactorily, and is as faulty as the over-dried or burnt sample. Hops are dried in 'oasts' or kilns, either over an open fire of anthracite, or by means of hot air heated by contact with steam pipes, or by passage over hot pipes through which the products of combustion of a furnace are passing. The temperature of drying is from 120° to 140° F., but considerable skill is required in the drying process (which lasts from eight to ten hours under ordinary conditions) to regulate the temperature according to the condition of the hops.

In order to give the colour required by brewers, a certain amount of bleaching of the cones is required; this is done by burning sulphur in the oasts during the first stages of the drying process. This sulphuring also has the effect of more or less sterilizing the hops, so that fermentation does not readily take place, and the growth of fungi is also prevented.

The use by brewers of substitutes for malt, and the contamination of one of those substitutes (glucose) by arsenic, caused some years ago a great many cases of poisoning in Lancashire, in which several deaths occurred. This led to an enquiry into the purity of brewing materials, and it was found that malt to a considerable extent, and hops to an infinitesimal extent, could contain arsenic if the coke or coal used in the open-fire system of curing were contaminated with arsenic. The relatively small quantity of hops used per barrel of beer made the danger of arsenic contamination through hops a negligible one; but the scare was used (in the opinion of some, always in a rising market) to depress the price of those hops which were found by tests (which both in the manner of sampling of the hops and in the method of application of the test were not free from inaccuracies) to be contaminated with a minute proportion of arsenic. As the method of entry of the arsenic into the dried hops is through the use of an impure anthracite in the open-fire drying process, it is obvious that the use of a pure fuel or of a hot-air system of drying would eliminate any risk of contamination.

After drying, the hops are mechanically pressed into bags or pockets containing about 1½ cwt., and marked with their place and year of growth. East Kent Goldings are the choicest of the English hops, and realize the highest price in the markets if in good condition. The value of hops to the brewer is due to their flavouring and preservative effects, and the mechanical action of the bracts for filtering purposes is also most useful. The valuation of a hop for brewing purposes by chemical analysis is not yet on a satisfactory basis, and there is still some doubt as to whether the determination of the resins will lead to an accurate determination of brewing values. The buyer is guided by the colour of the sample, its condition, the whole or broken character of the cones, freedom from evidences of insect or mould attack, its aroma and 'condition' as evidenced when the sample is rubbed in the hand; but it is difficult to reduce these characteristics to any accurate basis at present.

The system of selling hops has its peculiar characteristics. The hops are bought from the grower by the factor, who acts as the collector for the merchant, from whom the brewer buys his requirements. The factor and merchant are also agents for the sale of foreign hops, so that they have a more accurate knowledge of the conditions of the trade than either grower or brewer. The hop market is often of a very speculative character, the grower being tempted to delay the sale of his hops until the time when he thinks a better market may be secured, though in many cases this action has led to a considerable loss on his part.

Coming next to the annual cost of hop growing, the following figures may be taken as representing the average cost per acre:—

	£	s.	d.
Interest on capital for planting and erecting wirework (5 per cent on £60)	3	0	0
Rent, rates, taxes, &c.	4	0	0
Cutting bines	0	3	6
Repairing wirework	1	0	0
Manuring	10	0	0
Digging	1	0	0
Cutting	0	6	0
Stringing (string and labour)... ...	2	12	6
Tying and training	1	10	0
Sulphuring	1	7	6
Washing...	4	0	0
Catching wireworm	0	5	0
Skimming	0	7	6
Slip digging (twice)	0	18	0
Earthing...	0	2	0
	30	12	0

If a crop of 10 cwt. is grown.

	£	s.	d.	£	s.	d.
Picking	10	0	0			
Drying	4	10	0			
Pocketing	0	15	0			
Carriage, insurance, commission, sampling ...	3	10	0			
Insurance of pickers ...	0	5	0			
				19	0	0
Total cost				49	12	0

It will be seen from the above figures that a large proportion of the cost is for labour, and the labour cost per acre (exclusive of picking), assuming one man to 4 ac. and one horse to 10 ac. (for summer work), will be found to work out at not less than £15 per acre.

The hop crop is an expensive one to grow, and there is undoubtedly at the present time considerable overproduction, due to improved systems of cultivation and management, whilst the public taste in beer is changing, both as regards the amount consumed and the quality of the beer. Brewers are using less hops per barrel than formerly, as the following figures will show:—

	lb. hops per barrel.
1886–91	2·2
1901	2·02
1902	1·97
1906	1·85

The public taste now demands a lighter, brighter, less heavily hopped beer, and the aseptic conditions under which brewing is now carried on, and the smaller quantity of stock ales now

brewed, have rendered the use of hops for their preservative effects less essential. The industry is now passing through a phase of severe depression, not only in England, but in Germany and other hop-producing countries. It is probable that the ultimate result will be a smaller acreage confined to the best quality of hop land, and a reduction of the cost of production by the use of improved methods of cultivation and management. [M. J. R. D.]

Hop.—Parasitic Fungi.—Hop Mildew in the hop-growing counties is very destructive in some seasons. The first symptoms are pale spots on the leaves, followed by a white dusty or floury coating, consisting of the spores of *Sphærotheca castagnei*, one of the powdery mildews or Erysipheæ (see FUNGI). The interlacing network of fungus filaments lies on the surface, pegged down by suckers which enter the leaf tissues. The summer spores are formed in chains (see ROSE MILDEW for figures). As summer advances, numerous dark minute winter fruits are formed, which adhere to dead plants, and in the following spring open to allow escape of the ascospores. This same mildew has been observed on wild plants, many of them weeds in hop gardens, and these serve as sources of infection. The greatest damage is done to the hop when the mildew appears early and is favoured in its growth, as during a dull wet season; the fungus spreads rapidly and becomes established on the 'cones', which cease to swell, and shrivel. The mildew is frequently accompanied by large numbers of the hop aphis, and these also favour the growth of a sooty mould.

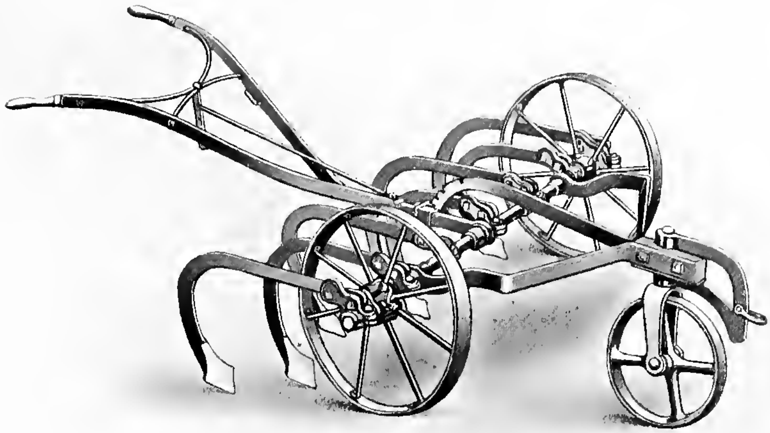
Treatment.—Apply flowers of sulphur to cover all the foliage, above and below. Special distributors for hand or horse power are sold by makers in the hop-growing districts. Three applications of the sulphur are recommended: the first before flowering, the second during flowering, and the third when the 'cones' are full-sized but before they become dry. [W. G. S.]

Hop, Insect Enemies of.—The hop pests are: *Phorodon humuli* (Hop Aphis), *Plectrocellis concinna* (Hop Flea), *Hepialis humuli* (Ghost Moth), *Agriotes* spp. (Wireworm), *Calocoris fulvomaculatus* (Needle-nosed Hop Bug), *Tetranychus malvæ* (Red Spider), *Blaujulus guttulatus* (Small Snake Millipede), *Eucanthus* (Hop Frog Fly), *Eupithecia* (Hop Pug Moth), *Hypena* (Hop Vine Snout Moth). See separate articles.

Hop-beech (*Ostrya vulgaris*) is a small tree belonging to a genus of the Carpineæ family of the nat. ord. Amentaceæ or catkin-bearers. It is very closely allied to the Hornbeam (*Carpinus Betulus*), and is found throughout central Russia associated with the latter, although the Hop-beech is far more frequent in the warmer tracts of southern Europe. In both trees the fruit is a nut about $\frac{1}{4}$ to $\frac{1}{3}$ in. in length; but in the Hop-beech the nut is enclosed in a hollow, conical, net-veined bract, while in the Hornbeam it is encircled at the base by a large flat-lobed or indented toothed bract. The Hop-beech is not a tree of the British woodlands, being only of comparatively recent introduction into our arboreta and botanic gardens. And even throughout the south of Europe, where it attains its finest development, it is of comparatively little importance as a woodland tree. As regards cultivation, it much resembles the Hornbeam. See HORNBEAM. [J. N.]

Hop-growing Machinery.—Hop-growing machinery has been much developed during recent years. Until spraying with solutions for destroying insects and fungi was adopted, and before the introduction of permanent wirework and elaborate methods of stringing, the machinery used in the hop gardens was extremely simple. There was indeed an exceptional conservatism in the methods of hop culture and in the implements employed. This conservatism in respect to some of the implements obtains in districts even now, but is rapidly passing away. During the past fifteen years, and largely during the latter half of that time, the work in the hop gardens has undergone changes which are probably unequalled in respect to the management of any other farm crop. Many of the tillage implements were (and in some districts still are) made with heavy wooden frames of primitive construction, with ill-shaped tines which without the dead weight of the frames would not face hard ground, and were very heavy in draught. The narrow alleys between the hills, of course, prevent the use of the wider implements used in ordinary farm work. For some time, light cultivators or grubbers, made of iron, possessing good stirring powers, have been in use; the lighter of these are known as shims, and the heavier as nidgets or nidyatts. The sickle-tine cultivator is now adapted to this work, and the hop cultivator, made in several sizes to adapt it to the width of the alleys, is suitable for working at deep or shallow levels. Certain makes of spring tooth harrows make an excellent shim for surface working. A hop-alley clod-crusher adapted for hop cultivation is made in a convenient form for breaking down hard, rough ground. The recognized necessity for spraying against attacks of aphides, &c., has demanded spraying machines suitable not only for large and small growers, but adapted to the several systems of growing in vogue. In the smaller machines hand power is relied upon, a hand pump being attached to the tank, and a constant spray is maintained through the hose by an air-vessel. Some of these machines have a two-manual double-action pump, which supplies four nozzles. For large gardens horse-power engines are used; the driving of the pump is effected by gearing taken from the axle. These machines are fitted with a large number of nozzles, so placed that they diffuse an ample quantity of solution as the machine is drawn along. Some of these are fitted with rocking frames to more readily adapt them to string work. On the largest hop farms, power-driven pumps are used to force the solution through mains into the hop garden; this is done so that the solution may be mixed conveniently to the water supply and boiling plant. Pumps with two barrels are used, each double-acting, and are arranged so that one barrel draws the water

1



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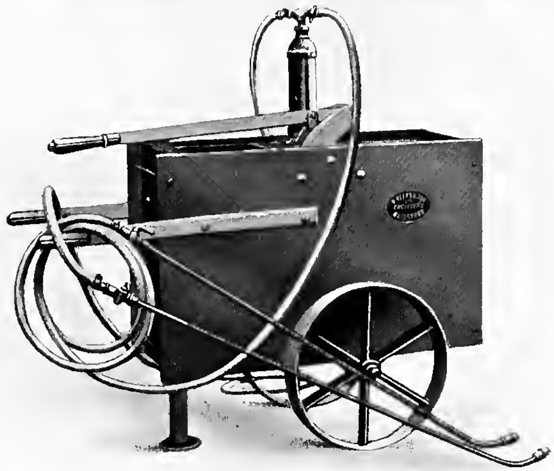

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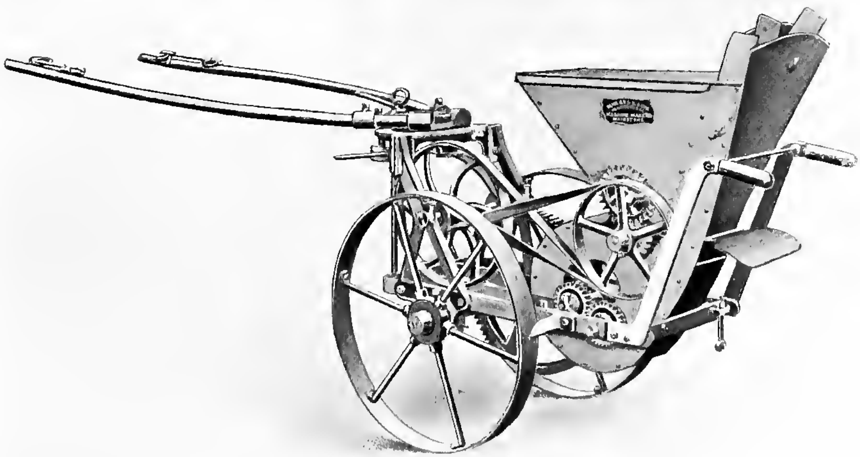
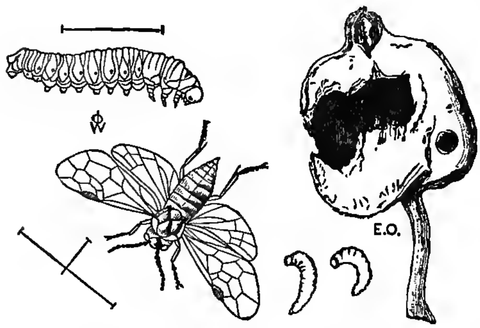


1, Howard Cultivator, as used for Hop Gardens. 2, Hand Spraying Machine.
3, Hop Sulphurating Machine. (Nos. 2 and 3 by W. Weeks & Son, Ltd.)

supply and feeds into the mixing plant, and the other delivers from the mixing plant into the hop-garden mains. Sulphurators are horse-drawn machines for diffusing powders such as sulphur on the growing hops to check the growth of mould, which in some seasons is very destructive. The sulphur is placed in the hopper and fed out so as to be brought under the influence of a strong blast, which forces it out through guides upwards, so that both in passing upwards and in falling the sulphur is brought into contact with the bine in the most effectual manner. To render the bine more suitable for litter, special chaffing machines cutting into 8-in. lengths are employed; these are made for hand power and steam power. Most large hop farms are provided with dipping tanks for creosoting hop poles and posts, and the greater durability of wood so treated well repays the cost. Both portable and fixed tanks are used.

[W. J. M.]

Hoplocampa testudinea (the Apple Sawfly) causes much injury in certain years to



Apple Sawfly (*Hoplocampa testudinea*)

Female Sawfly and Caterpillar, magnified, with lines showing natural size; caterpillars, natural size; and infested apple.

the young fruit in the south of England. The attack can be distinguished from that of the codlin moth by the nature of the injury and by the appearance of the grub. The tunnelling of the fruit is not so regular, but consists mainly of a large black excavation, and the grub is of the usual sawfly type, having twenty feet in all, whereas the codlin caterpillar has only sixteen feet.

The sawflies appear simultaneously with the blossoms, and the eggs are laid just below the calyx. The grubs eat into the developing fruit and stunt or destroy it, the injured apples generally falling while still very small. The fully fed caterpillars burrow about 4 in. beneath the surface of the soil, and the flies emerge in the following spring. It is almost always young trees which suffer. The injured fruit cannot be saved, but the following measures may be taken against recurrence: (1) Stripping off and burning the injured fruit during attack, and collecting immediately and destroying the young apples which fall as the result of the attack. (2) Preventing the emergence of the flies in the following spring by some treatment of the soil beneath the trees. Mere disturbance of the soil turns many of the grubs up to the birds, or it is sometimes practicable to remove and bury deeply the surface earth to the depth of 5 or 6 in.

[C. W.]

Hoppers.—Hoppers are receptacles placed over machines to hold and conduct material to be dealt with by the machines. A water funnel for conducting liquid into the narrow mouth of a vessel is a hopper; but ordinarily the term 'hopper' is applied to structures forming part of a machine used to deal with solid substances, as in grinding mills, turnip cutters, &c., when they are more or less funnel-shaped. In corn drills, manure distributors, &c., they are often of considerable length as compared with their breadth, and practically always they are wider at the top than at the bottom. As a rule they are not fitted with mechanism, but when made to deal with substances which do not readily flow they are fitted with stirrers. In corn mills they are often supplied with a trough at the bottom, which is made to vibrate by a jigger motion so as to feed the corn into the mill, the flow being regulated by a regulating port at the base of the hopper. [W. J. M.]

Hop Trefoil.—Hop Trefoil is the name sometimes applied to Hop Clover (*Trifolium procumbens*), but more commonly to Yellow Trefoil (*Medicago lupulina*). See MEDICAGO and TRIFOLIUM.

Hordeum, the genus of the nat. ord. Gramineæ to which the barley belongs. See BARLEY.

Horehound, or **White Horehound** (*Marrubium vulgare*), is a perennial herbaceous dicotyledonous plant belonging to the nat. ord. Labiatæ, which is much used as a domestic remedy for coughs and asthma. The plant is covered all over with whitish woolly hairs. The branched leafy stem rises from a short stout rootstock to a height of 12 or 18 in. The leaves have a rather long petiole, and a much wrinkled, soft, heart-shaped blade about 1 in. long, becoming egg-shaped higher up. The flowers, arranged as dense whorls in the axils of the upper leaves, are about ½ in. long, with a ten-toothed calyx and a two-lipped white corolla; the upper lip is split and the lower spread out into three lobes, the middle one being very broad. The position of the four stamens low down in the tube of the corolla (*included stamens*) marks off Horehound from all other British Labiates. This plant very rarely occurs wild in Britain, and can scarcely be considered a native. It is easily propagated by division of the rootstock or by seeds sown in early spring. The plants should be 18 in. apart, and flourish on a dry situation.

[A. N. M'A.]

Hornbeam (*Carpinus Betulus*), the chief timber tree in the genus Carpinus, belonging to the Carpineæ family of the nat. ord. Amentaceæ or catkin-bearers, is either indigenous or else was introduced into Britain in the 15th century. Its nearest relative is the Hop-beech (Ostrya), grown occasionally in arboreta (see HOP-BEECH), from which it is distinguishable by having its fruit, a small flattish nut ¼ to ⅓ in. long, encircled at the base by a large flat-lobed or in-

dented toothed bract, while in the Hop-beech it is enclosed in a hollow, conical, net-veined bract. Among our native trees and shrubs, however, it is most closely related to the Hazel (see HAZEL), from which it is easily distinguishable by its size and general appearance, its greyer and often fluted stem, its smaller, narrower, and smoother leaves, its small yellowish flowers appearing in May (long after the Hazel has flowered), and its small flattish nut (seldom one-quarter of the size of a hazel nut) attached to a flat, oblong, serrated bractea having two lateral lobes. In general appearance it far more closely resembles the Beech (see BEECH) than any of the other trees more nearly related to either of them

Hornbeam (*Carpinus Betulus*)

1, Male flower. 2, Female flower. 3, Fruit. 4, Section of fruit.

botanically; but Hornbeam is easily distinguishable from Beech in its winter leafless condition by its smaller buds lying closely pressed to the twigs and its usually fluted stem, and in summer by its doubly serrated leaves. The Hornbeam is found throughout all Central Europe, but attains its finest development in Western Russia, where it takes the place of the Beech and forms one of the chief woodland trees over large tracts. Thence it extends southwards towards the Mediterranean countries and into Western Asia. Although possibly also indigenous to the warmer portions of the British Isles, it was only introduced into the north of Scotland. On a good loamy soil Hornbeam can attain a height of 60 to 70 ft. and a girth of over 6 ft. But such dimensions are very exceptional, and usually it forms only a short stem, then ramifies into a spreading crown. Its whitish wood is very hard, heavy, and tough though cross-grained and difficult to work. On the Continent it is largely used for cogs, wheel-hubs, moulds, plane boxes, wedges, and other work requiring very tough wood, and it is the best wood for fuel and charcoal. But in Britain it is seldom grown as a timber tree in high-woods, except to fill blank spaces in damp spots, where its hardiness against frost enables it to grow when other hardwoods are killed off—for it is one of the hardiest trees in this respect. It is also endowed with a strong reproductive capacity and a considerable power of enduring shade, so that it is often to be found in damp patches among coppice underwood, where Hazel, Ash, and Oak cannot thrive. And here, when cut low down close to the ground, it often throws out root suckers as well as stool shoots. As it stands clipping and trimming very well, it is highly suitable for hedging purposes, being both ornamental for garden cultivation and also hardy enough to form field fences, to which purpose it is often put (in Scotland especially) in places unsuitable for the Hawthorn. As a tree it thrives best on a deep, fresh or moist, loamy, limy, sandy, or marshy soil; while as a hedge plant it does well on all except chalky land (where Beech is preferable). The nuts ripening in October may either be sown when gathered, in which case they lie over till the second spring before germinating, or else stored for a year or for sixteen months before being sown on the seedbeds. The one-year-old seedlings should stand in the nursery lines for two years before being planted in the open. [J. N].

Hornblende, the commonest amphibole (see art. AMPHIBOLE), occurring in most of the igneous rocks known as diorites and aphanites, in many andesites, in some granites, and in the altered and recrystallized basic masses styled hornblende schists. It often arises as a product of the slow subterranean alteration of pyroxene, or where granite invades basic igneous rocks. It is a silicate of magnesium, iron, and calcium, with alumina and ferric oxide, containing molecules of the composition (Mg, Fe, Ca)SiO_3, *i.e.* of the normal amphibole and pyroxene type, and others in which Al_2O_3 and Fe_2O_3 play a part. Miers (Mineralogy, 1902) writes the formula $Ca(Mg,Fe)_3(SiO_3)_4 . CaMg_2Al_2(SiO_4)_3$. Hornblende is green, brown, or black, commonly opaque, and occurs in prismatic crystals of the monoclinic system, which are generally longer than those of augite. In many of the schists it is almost granular. It usually has a more fibrous look than augite, and its cleavages (see art. AMPHIBOLE) distinguish it from schorl or black tourmaline, another prismatic mineral common in granite veins. It breaks down into chlorite on weathering, imparting a grey-green colour to the rock. In many masses the following successive changes may be traced: augite (the mineral formed on the original cooling of the mass), diallage, hornblende, chlorite.

[G. A. J. C.]

Horns, a general name for various kinds of

hard outgrowths on the dorsal surface of the head of certain mammals—cattle, sheep, antelopes, deer, rhinoceros, &c. They are primarily of service as weapons, and are often stronger in the males, being indeed confined to these in some antelopes, and in all the members of the deer tribe except the female reindeer. We may leave out of account here: (1) the wartlike, purely integumentary horn or horns of the rhinoceros; (2) the horns of the giraffe, which have a covering of hairy skin where the sheep or cow has a sheath of horn; and (3) the horns of the pronghorn (Antilocapra) of the Rockies, in which the sheath of horn has three peculiarities—it includes a cornification of hairs as well as of epidermis, it shows a short branch at the base, and it is shed annually after the pairing season by the growth of a fresh sheath beneath it. There remain two familiar types of horns—the antlers of Cervidæ and the so-called hollow horns of cattle, sheep, goats, and antelopes.

The antlers of deer consist of three parts: (*a*) a bony basal portion, an upgrowth or apophysis of the frontal bone, which is not shed; (*b*) a bony main portion, an epiphysis or independent ossification in the dermis, which is shed; and (*c*) a covering of richly vascular skin, which dies and gets rubbed off after the antler has reached its limit of growth for the year.

The horns of cattle, sheep, goats, and antelopes (Cavicornia, as they are called) consist of three parts just as antlers do: (1) a small basal portion, which is part of the frontal bone; (2) a large permanent core of bone, which corresponds to what falls off in stags; and (3) a permanent sheath of horn, which is formed by the epidermis and corresponds to what falls off in the pronghorn. The small *os cornu*, which lies in the young lamb to the outside of the protuberance of the frontal, and originally independent of it, was discovered in 1829, but it has often been lost sight of in descriptions of horns, which has led to the prevalence of erroneous comparisons. The *os cornu*, which is practically a dermal bone or scute, soon fuses with the basal portion, which is practically part of the frontal, and all distinction of the two is then impossible. It often happens that air sinuses developing in the frontals extend into the basal portion and core of the horn. The horny sheath is a product of the epidermis, which, along with a richly vascular dermis, extends over the bony part of the horn. The growth of the horny sheath may far exceed that of the bony part, and the graceful final results are familiar to all.

There are many points of great interest in regard to horns. Thus the fluctuations in the growth of the horny sheath may be marked by rings at the base, and these are sometimes so regular, as in cows, that they may be used as an index of the animal's age. Horns are often larger in the males, or restricted to the males; their growth and decay in stags is wrapped up with the sexual condition of their possessors; they are often used by the males in fighting for the females; and abnormalities in the horns are often associated with abnormality in the reproductive organs. In the basal growth of the horny sheath in cattle, hairs may be incorporated in the cornification, and the first horn-cap of calves is shed—two facts which link the typical horn of Cavicornia to the aberrant horn of the pronghorn.

The following table, slightly modified from one given by Weber, may make the accurate comparison of different types of horns easier:—

	Basal Portion. Apophysis of Frontal Bone.	Main Portion. Dermal Bone.	Integumentary Sheath.
Cervidæ	Short base.	Deciduous 'antler'.	Deciduous 'velvet'.
Pronghorn	Short base.	Permanent core.	Deciduous horny sheath.
Typical Cavicornia	Short base.	Permanent core.	Permanent horny sheath.
Giraffe	Short base.	Permanent core.	Permanent hairy skin.

Horns are often ground up and used as a manure. See Nitrogenous Organic Manures.

[J. A. T.]

Horns, Breeding-out of.—In the wild state all bovine cattle have horns, a provision of nature for self-defence. In the domesticated state, animals with horns such as those of the Ayrshires or Highland cattle have a very picturesque appearance, but from the point of view of usefulness horns are no longer required for defence; they are weapons of offence, and to the stock-owner thus become a source of trouble and loss. The consequence is, that in the case of breeds with horns it has been customary for a long time to saw or cut them off before shutting the animals in feeding boxes at the beginning of the fattening period. They are often removed also when the animals are calves, by cutting off the horn (see art. Dishorning) or by destroying it by any caustic material.

It is only, however, during recent years that any attempt has been made to breed out the horns of those pure-bred animals that are naturally horned. This is easily done by the use of pure-bred bulls of any of the polled breeds, as the polled characteristics seem to be dominant over the horned. But while the first generation is thus rendered hornless, the colour, size, form, and general character of the horned breed experimented on is departed from, and although the cross-bred animals when mated with others do not breed true, we know from Mendel's law that when first-cross animals are mated among themselves about one in every sixteen of the offspring will resemble either of the pure-bred grandparents, and when mated with pure-bred animals of its class will breed pure-bred stock.

In 1893 Mr. M. Boyd of Bobcaygeon, Ontario, Canada, mated 2 pure-bred Polled Angus bulls with 10 pure-bred Hereford cows. Of the offspring, one bull calf, which had no horns, and was black all over the body, but had a pure-white Hereford face, was retained for further experiment. This bull, called Cross Patch, was mated with 13 Hereford cows in 1895 and again in 1896, and from the progeny 2 bulls and 3 cows were retained, which were polled, and had all the markings of pure Herefords. The two bulls were used in separate herds, and in both cases, when used with horned Hereford cows, they produced about the same number of polled animals as if they had been pure-bred, and yet they were only three-fourths Herefords and one-fourth Polled Angus. One of these bulls, called Verulam, was mated in 1897 with 14 pure Hereford cows, and of 13 calves produced, 5 were horned, 5 polled, and 3 were uncertain. The colour of one is not stated, but the other 12 are said to have been red with white faces and other Hereford markings, yet these animals were seven-eighths Hereford and one-eighth Angus.

Encouraged by the facility with which horns may be bred out of any breed, and by the knowledge that among Herefords, and probably among all horned breeds, a calf is occasionally born which has no horns, or horns which are only partially developed, Mr. Boyd determined to try to find out a pure-bred calf which had no horns, in order that he might watch the effect it would have when mated with pure-bred cows with horns. He communicated with about 2000 Hereford breeders, and as the result of his enquiries he came across 4 bulls and 8 heifer calves which were presumed to be pure, and which had no horns. Two of these bulls were good specimens of the Hereford breed, and both were bought by Mr. Boyd. Each of these bulls had from ten to twelve generations of registered pure-bred parents, and they themselves were registered under the names of Wilson (126,523) and Variation (152,699) in the American Hereford Herd Book. Wilson (126,523) was bred by Thomas Gates, Lime Springs, Iowa, and was born on 10th April, 1901. Variation (152,699) was bred by James Thomas, Harris, Mich., and was born on 26th August, 1902. Both of these bulls were mated with pure-bred Hereford cows having horns, Wilson being put to a few cows in 1903, and a considerable number in 1904, while Variation had also a moderate number in 1904. For these two years the offspring of each was as follows:—

Wilson, 1904 = 16 bull- and 11 heifer calves ...	27
Wilson, 1905 = 23 bull- and 20 heifer calves ...	43
	70
Variation, 1905 = 17 bull- and 12 heifer calves	29
Total ...	99

Five of Wilson's calves died when they were young, and at that date it could not be determined with certainty whether or not they were likely to have horns. Of the remaining 65, there were 38 which were polled, *i.e.* about 60 per cent, and 27 which had horns. Later on it was, however, found that some of the 38 which in the autumn of 1905 were presumed to be polled, turned out to have horns or scurs, which would leave the proportion of each about 50 per cent horned and 50 per cent polled.

Of the 29 calves by Variation, one died when young, and of the 28 remaining, 22 were polled on 30th November, but later on several of them developed horns or scurs. For the four years 1904–7 there were, in the autumn of 1908, 43 per cent of the heifer calves and 49 per cent of the bull calves polled, where the polled sport Wilson (126,523) was mated with horned cows. For the years 1905–7 there were 66 per cent of the heifer calves and 45 per cent of the bull calves polled, sired by the original polled sport Variation (152,699), when mated with horned cows. For both bulls we have up to date an average of 5·45 per cent of the heifer calves and 47 per cent of the bull calves polled, or an average for the whole of 50·75 per cent polled. As far as breeding is concerned, both of these bulls are considered as pure-bred Herefords and are registered as such, but as polled specimens of the breed they can scarcely be considered pure, seeing their ancestors on both sides had had horns for many generations. When pure-bred specimens of such polled breeds as the Aberdeen-Angus or Galloway are mated with horned breeds such as the Shorthorn or Ayrshire, few of the calves develop horns, and many of these are only scurs. It therefore seems that in the matter of horns these original polled sports Wilson and Variation have had about the same amount of prepotency as if they had been first crosses between a polled and horned breed.

There are five polled bulls by Wilson (126,523) out of horned cows, which for one season have been mated with horned cows, the offspring of which are as follows:—

Bulls.	Bull Calves.		Heifer Calves.	
	Horned.	Polled.	Horned.	Polled.
Reformation (227,648), by Wilson (126,523) ...	1	0	1	1
Reformation 2nd (231,619) ,, ...	2	3	1	0
Olion (231,615), by Wilson (126,523)	0	1	0	0
Deviation 3rd, ,, ...	3	2	4	2
Deviation 2nd, ,, ...	5	9	4	7
	11	15	10	10

This is 21 horned and 25 polled calves, which is 37·5 per cent horned and 62·5 per cent polled. If Wilson's prepotency in the matter of horns is presumed to have been 50 per cent of his

calves, his offspring may be presumed to be able to get 75 per cent of their calves polled, when mated with horned cows. Although the percentage of polled calves from the original polled sport bulls Wilson and Variation works out at this date as slightly over 50 per cent polled, those from Wilson were somewhat less, and it may ultimately be found that he was less prepotent than Variation. For the four years that Wilson has been mated with horned cows, 46 per cent of his offspring have been polled. If this is increased by one-half for the offspring of his calves, we get 69 per cent as the proportion we might expect to be polled, whereas with the limited numbers yet born it works out at 62·5 per cent. With a larger number of calves, the probability is that the proportion would come out nearer that anticipated. All these calves are eligible for the Hereford Herd Book.

The above experiments were at first carried out by Mr. Boyd on his farm at Bobcaygeon, Ont., but latterly at Red Deer Hill, near Prince Albert, Sask., where he has a herd of several hundred pure-bred Herefords, a considerable proportion of the young animals of which are now polled. [J. S.]

Horns, Diseases of.—Except from injuries, the horns of cattle may be said to be practically immune from disease, differing therein from hoofs, which develop so many defects. Curvature and ingrowth towards the head and actual piercing of the bone is not rare, and this should be prevented by sawing off the points at suitable distance from the tender core. Sharp-pointed horns may have to be reduced for the safety of other animals. When a horn is broken, the core is commonly left, but the surface lacerated, and being very vascular it bleeds freely. It should be dressed with carbolized oil and bound up in tarred tow or other antiseptic bandage, after which a defective horn will take its place. If the core is broken off, the hæmorrhage may have to be stayed by a hot iron, in the absence of perchloride of iron or other styptic. Abscesses in the horn core sometimes follow on injuries, and the subject suffers much pain and febrile disturbance. The horn should be bored with a centre-bit to liberate pus, and a cold lotion of 5 per cent carbolic acid applied on a roll of soft material. [H. L.]

Horse.—The genus *Equus*—which belongs to the Perissodactyl section of the Ungulata or Hoofed animals—includes the domesticated horses (often united in the species *E. caballus*), the asses, and the zebras. Some of the important characters of the genus are the following: there is one functional toe (the third) on each foot, its last joint is enclosed in a horny hoof; the second and fourth digits are represented by splints; there is a callous pad or chestnut on the inside of the fore limbs or on both pairs (perhaps the residue of an aborted odoriferous gland); the orbit in the skull is completely encircled by bone (a distinction from tapirs and rhinoceroses, which also belong to the odd-toed or Perissodactyl section of Ungulates); there are eleven teeth on each side above and below, namely, three strong incisors marked by a deep infolding or pit, the canines or 'tushes', which are small or lost in full-grown mares, a rudimentary first premolar or 'wolf's tooth', three other premolars, and three molars. According to some classifications, the Equidæ with chestnuts on all the limbs, with long hairs starting from the root of the tail, with short ears and broad hoofs, form the genus *Equus* in the strict sense, in distinction to the asses (*Asinus*) and zebras (*Hippotigris*). Whether these should all be ranked in one genus *Equus*, or kept in three genera or sub-genera, is still under discussion, and must remain a matter of opinion and a question of convenience until we reach greater certainty in regard to the evolutionary relationships of horses, asses, and zebras.

In regard to wild horses, the generally accepted view is that the only living wild species which is closely related to the domesticated horses is Prejvalsky's horse (*Equus przewalskii*), discovered in 1879 in the Mongolian deserts. Some have maintained that this interesting creature is a hybrid between the wild ass and a feral horse, but the weight of authority is in favour of regarding it as a distinct species. (Compare what is said in art. ATAVISM.) The colour is somewhat variable; there is a narrow dark dorsal stripe (scarcely visible in the winter pelage), an occasional shoulder stripe (sometimes seen on the ass, never on the domestic horse), and there may be faint cross bands on the feet; the distribution of hair on the tail is midway between horse and ass—short and mule-like on the upper half, long and horse-like on the lower half; the mane is erect, and there is no long forelock. There are four 'chestnuts' on the legs. Noack has pointed out some resemblances between Prejvalsky's horse and the extinct diluvial horse, and Salensky holds the view that it is a generalized type between horse and ass, and near the common ancestry of both. Twenty-three of these wild horses were brought to Hamburg in 1900 from western Mongolia by a costly expedition sent out by Carl Hagenbeck. Whether Prejvalsky's horse is or is not the ancestor of the European domestic horse, it is quite a different animal, and we are forced to conclude that the horse (*Equus caballus*) has become extinct as a wild species. All alleged wild forms of this species, like the mustangs and broncos of North and South America, are *feral*, that is to say domesticated animals run wild. As they seem to get on well, it is an enigma why the wild stocks should have disappeared. There is some doubt in regard to the Tarpan, of which Sir William Flower, in his interesting book The Horse (London, 1890), says: 'The nearest approach to truly wild horses existing at present are the so-called Tarpans, which occur in the Steppe country north of the Sea of Azov, between the river Dnieper and the Caspian. They are described as being of small size, dun colour, with short mane and rounded obtuse nose.' Beddard notes that 'their general build and appearance is highly suggestive of the wild horses sketched by primitive man upon ivory'. It may be, however, as Flower admitted, that the Tarpans were feral, or they may have been hybrids. We use the past tense because the Tarpans seem to have been exterminated, some

authorities putting the date of their disappearance as far back as 1876. It remains to be noted that onagers or kulans, kiangs, dziggetais, and the like are all wild asses—with relatively long ears, upright mane, short hair at the root of the tail, chestnuts on the fore legs only, and a uniform coat. The extinct quagga and the zebras may be sufficiently distinguished by their stripes.

As to the pedigree of the horse genus (Equus), the discovery of a long series of extinct forms, well seen in the museums of New York and Yale, shows that a starting-point may be found in small Eocene forms (Hyracotherium) with four toes in front and three behind, and that the lineage is continued (age after age) through a series increasing in size and decreasing in the number of digits until we reach the present-day one-toed species of Equus. This pedigree, which has found fine exposition many times, notably perhaps in Huxley's American Addresses, presents many puzzling features, but it is one of the completest and most striking instances of a well-preserved genealogical series. It illustrates evolution, as it were in process, for the gradations are very gradual, and the advances in the adaptation of the limb to swifter locomotion, of the teeth to better chewing, and so on, are such as may be reasonably interpreted in terms of the selection of relatively fitter variations. We must note, however, that it is not to be supposed that the links in the evolutionary chain form a continuous direct lineage; in many cases it seems that a link, that fills up a gap, really belongs to some collateral series. The relation between the evolution in the Old World and that in the New is puzzling, but it may be said that while the most primitive representatives of the hippoid race are to be found in both, the great theatre of horse evolution was in North America, whence immigrants passed time after time to Europe and Asia by a northern land connection. Schlosser, one of the great authorities, writes: 'The horse lineage had early representatives in Europe as well as in North America, but only the New World ancestors are of essential importance. The Old World stocks all died out sooner or later without leaving descendants, but the European series was renewed over and over again by immigration of American types. From Pliocene times onwards, however, the Old World stock (thus renewed) seems to have become again progressive.' For it is very remarkable that the horse tribe seems to have come to a full stop and actually disappeared in North America in the Early Pleistocene, while the American migrants to Eurasia gave origin to *Equus caballus fossilis*, to the Western domestic horse, to Prejvalsky's horse, to the Eastern domestic horse, besides asses and zebras in considerable variety. Thus in later days the theatre of evolution was shifted from West to East.

The disappearance of the horse tribe in North America is such a strange riddle that it deserves more emphasis. It seems certain that when the Spaniards explored the New World they found no horses on either continent. 'The Indians were quite unfamiliar with them, and at first regarded the strange animal which the newcomers rode, with wonder and terror' (Matthew). 'In spite of perfection of adaptation the American horses became entirely extinct before the discovery of America by Europeans. This is all the more remarkable in view of the fact that conditions in our west are such that the few horses which escaped from the Spanish explorers have increased so marvellously in numbers, evidently finding these conditions much to their liking. Long before domestication the horse was hunted for food. Professor Osborn states that 'one of the bone heaps of the Solutréen period is estimated to include the remains of over 80,000 horses'. Even this great slaughter would not be sufficient to cause extinction, for before the invention of firearms not one race of large mammals succumbed to the lords of creation' (R. S. Lull, Evolution of the Horse Family, American Journal of Science, 1907). The suggestion of disease as the exterminator is improbable, for there is little disease among wild animals. It has also been suggested that the winters became too cold, that there were great droughts and great fires, that competition with bisons, antelopes, and prehistoric hunters was fatal. The disappearance of the horse in America remains an unsolved problem.

Let us now turn to the geological history of the horse family in greater detail. (1) The horse-like animals probably sprang from an extinct group of mammals known as Condylarthra—first Eurasian, and then American—with five toes on each foot and with a large part of the sole on the ground. One of these, *Phenacodus primævus*, was called by its discoverer, Professor Cope, a 'five-toed horse', but this is not to be taken too literally. (2) 'The first undoubted horse-like animal appearing in the rocks of North America is a little creature not more than eleven inches high, known to science as *Eohippus*. This interesting animal has already made a long stride in the direction of the modern horse, as the number of toes is now reduced to four in front and three behind, and the bones of the wrist and ankle have shifted so as to interlock, which greatly strengthens the foot' (Lull). It seems that Eohippus was represented in Britain, and it is possible that migrants by way of Asia and what is now the Behring Strait started the American stock. Apparently more primitive than Eohippus is the 'coney-like beast' Hyracotherium, but only the skull is known. (3) 'Commencing with the Hyracotherium, twelve stages have been recognized from as many successive formations, showing the gradual evolution of the race into its modern form, and each stage is characteristic of its particular geological horizon. Besides the main line of descent which led into the modern horses and zebras, there were several collateral branches which have left no descendants' (W. D. Matthew, The Evolution of the Horse, American Museum Journal, 1903).

Of the stages in the evolution of the horse after Eohippus and Hyracotherium we may mention the following: Protorohippus (Eocene), with four toes in front and three behind (the side ones behind touching the ground). It seems to have been about 14 in. high, and the evolu-

tion of speed had begun. During the Eocene times North America was in great part forest-clad, but 'the moist climate gave rise to many streams and lakes, along the shores of which grew sedgy meadows that in turn gave rise to grassy plains. These were the conditions under which the horses made their first appearance, and the increasing development of grass lands gave the initial trend to their evolution' (Lull).

Somewhat later, in the Oligocene, Mesohippus makes its appearance, the hind foot with three toes as before, but the fore foot with the fifth toe reduced to a splint, so that three remain, the side ones touching the ground. 'The middle toe is now much larger than the side toes, which bear little of the weight of the animal.' The teeth have become more complex. One of the species was the size of a sheep. Among the specimens in the Yale Museum is a nearly perfect skull of a new-born foal. Of the conditions in the Oligocene, Dr. Lull writes: 'The drying up of streams and lakes, due to increasing aridity of climate, gave great impetus to the development of broad meadow lands and to the true prairie as well. Thus there were three conditions—woodland, meadows, and dry prairie—which seem to have given rise to several parallel lines of evolution, some of which terminated, being overcome in the struggle for existence, while others flourished and gave rise to the horses of the Miocene.'

Of the Miocene types we may select Protohippus, with three toes on each foot, but only one touching the ground. The short-crowned teeth without cement are now replaced by long-crowned cement-covered teeth like those of the modern horse. It was about 36 in. in height at the shoulder, and had a wide distribution from Texas to Montana and Oregon. In a closely related genus, Merychippus, we find the first instance of the completion of the hinder border of the orbit (a bar from the frontal bone joining the zygomatic arch). Of this genus Dr. Lull writes: 'Merychippus is of especial interest, and is in the direct line of descent, through some of its species giving rise to all subsequent Equidæ'. The forest horse, Hypohippus, with spreading three-toed feet, suited like the reindeer for soft ground, is a good example of those horses that became extinct during the Miocene, leaving no descendants, and Anchitherium, found both in Europe and in America, was probably also on a side branch. Of the Miocene period Dr. Lull writes: 'This was a time of continental elevation and great expansion of our western prairies, and a consequent diminution of the forest-clad areas'. Many forms very perfectly adapted to soft herbage became extinct, 'but the great majority were more plastic, and in consequence underwent a remarkable development, during this period reaching the culmination in numbers and kinds'.

In the Pliocene there was a wide representation of the Old World genus Hipparion, most of the species still three-toed. It was probably derived from the American Neohipparion, a swift deer-like animal, about 40 in. in height at the shoulder. 'In the Siwalik beds of India is found a one-toed Hipparion, and it has been suggested that the modern zebras may be the living descendants of this genus. It is certainly not in the line to the common horse, *Equus caballus.*' It is in the Upper Pliocene beds of Eurasia and North America that the modern horse, Equus, appears—the climax of a long evolutionary progression.

It is a remarkable story this, well worth reading in detail, how in early Eocene times there lived small five-toed quadrupeds of a generalized type, how the descendants of these were gradually specialized throughout long ages—losing toe after toe till only the third remained, becoming taller and swifter, acquiring more complex teeth and larger brains. Very gradually the light-footed runners on tiptoe of the dry plains were evolved from the short-legged splay-footed plodders of the Eocene marshes. Let us briefly consider the anatomical changes involved. (*a*) In the Condylarthra, among which the starting-point of the whole lineage is to be sought, there were five toes. In the earliest definite ancestors of the horse whose feet are known, namely the somewhat civet-like Eohippus, there were four complete digits in front and a small slender vestige of the thumb, while in the hind foot there were three complete digits and a vestige of the little toe. Thus the first two digits to disappear were the innermost and the outermost. Gradually the second and fourth followed, leaving the third to bear the whole burden. This illustrates specialization by reduction of parts. (*b*) With the reduction of toes is associated a lengthening of the lower leg and foot, a strengthening of the third digit, a restriction of the free movement to swinging forward and backward, a change in the joints from the ball-and-socket type to the pulley type, a consolidation of the radius and ulna, of the tibia and fibula, into one bone. (*c*) As the animal increased in length of limb it had also to increase in length of neck in order to reach the grass with its mouth. (*d*) 'The change in the character of the teeth from "brachydont" or short-crowned to "hypsodont" or long-crowned enables the animal to subsist on the hard, comparatively unnutritious grasses of the dry plains, which require much more thorough mastication before they can be of any use as food than do the softer green foods of the swamps and forests' (Matthew). The changes in the horse itself, which we have just illustrated, doubtless went on in intimate correlation with changes in the external conditions. The evolution of the horse is wrapped up with the evolution of the plains. Its ancestors of the horse tribe probably lived in the warm luxuriant forests, but as a colder drier climate set in and the forests shrunk, the progressive hippoids took more and more to the open. Perhaps the primitive habit of sweeping in herds from place to place in search of good grass lies at the root of their migratory disposition, for at an early date the horse became cosmopolitan and found a home in the plains of all the continents except Australia.

It is of interest that in the embryonic development of the horse there is a series of stages which to some extent correspond with the historical steps represented by forms like Eohippus,

Mesohippus, Protohippus, Merychippus, and so on. Professor Cossar Ewart has shown, for instance, that the small nodule at the end of the metacarpal splint is separate in the embryo, and is the representative of one or more of the joints of the corresponding digit. It is well known that in rare cases the splint bones are represented by complete digits, so that a three-toed horse, such as the one Julius Cæsar rode, may still walk upon the earth. Extra digits are more frequent on the fore feet, and many of them are undoubtedly comparable to a sixth finger in man—mere duplications without historical interest. Many good authorities believe that there is a second class of cases, where the extra digits are well formed and in their proper position, which should be regarded as reversions to ancestral type (see ATAVISM and REVERSION).

As we approach the modern horse, uncertainties do not disappear. From Miocene forms like Merychippus, the widespread Hippidion which lived into the Pliocene may have been derived, and Hippidion may have given origin to Equus. There are fossil species of Equus in North America (*E. excelsus*, &c.), which survived longest in Alaska and California, but eventually died out. Similarly, there were species of Equus in South America, and these also came to an end. Meanwhile, however, migrants to the Old World gave the equine race new life. A Pliocene species known as *E. stenonis* may have been the ancestor of the Western horse, and also of zebras and African wild ass. Another Pliocene species, *E. sivalensis*, or the same species under a different name, derivable at all events from Hippidion, may have been the ancestor of Prejvalsky's horse, of the Eastern horse, and the Asiatic wild ass.

During the Palæolithic and Neolithic prehistoric periods, horses with skulls, &c., like those of our domestic horse were very common in western and central Europe. This is demonstrated by abundant bones in superficial deposits and in caves. A few drawings by cave-dwellers are known, showing 'a clumsy-headed and short-limbed brute, with an upright or 'hog' mane, and a rough tangled tail, which was probably only sparsely haired near the root'. It is doubtful, however, whether the Palæolithic and Neolithic hunters had domesticated the horse. Dr. Munro, for instance, vigorously denies this, pointing, in evidence, to the rarity of the bones in tumuli and waste heaps. The horse seems to have been introduced into Egypt by the Hyksos or Shepherd Kings, probably from Assyria and Babylonia. The Assyrians may have got their horses from some part of central Asia, apparently not from Arabia, where the horse was a comparatively recent introduction. Professor Ridgeway, in his Origin and Influence of the Thoroughbred Horse (1905), has sought to show that the Arab horse originated in Libya, but there seems to be no evidence of fossil ancestors of *E. caballus* in Africa. It is not improbable that the Hebridean 'Celtic' pony, Professor Ewart's *E. caballus celticus*, is a survival of the wild horses which were domesticated in western Europe, just as Prejvalsky's horse may be a still-wild survival of the wild horses which were domesticated in the East, and that repeated importations of the Eastern horses into Europe have complicated the pedigree. Professor Cossar Ewart recognizes three distinct kinds of living horses, namely, Prejvalsky's, the Celtic pony, and the *Equus caballus typicus*, *e.g.* the Norse breed, and he has made out a strong case for the multiple origin of domesticated horses and ponies (Trans. Highland and Agric. Soc. of Scotland, 1904).

In some minute features, such as the 'button' at the distal end of the splints, the horse is linked back to its polydactyl ancestors. Similarly in some of its habits it shows survivals of behaviour which date from the wild life in the open plains. In his well-known Wild Traits in Tame Animals (1897), Dr. Louis Robinson has referred to some of these. In the plains the young colts ran with their mothers, and to this day they do not take full meals like calves. When alarmed, horses hold their heads high, as on the plains; they bite very closely when grazing; in both respects they differ from cattle. 'Shying' is a relic of instinct of swerving suddenly from suspicious rustling or the like, which used to mean the presence of a lurking tiger or other enemy. Perhaps 'bucking' was originally a method of dislodging the leopard or panther. Darwin discusses the laying back of the ears and the screaming when attacked by wolves. It may be noted that while present-day habits may be misinterpreted in the light of the past, this is better than not interpreting them at all. [J. A. T.]

Horse Breaking.—The methods adopted in the breaking of horses are fully described under the heading BREAKING.

Horse-chestnut, a large tree indigenous chiefly throughout the mountainous regions of Greece and Asia Minor, and introduced into Britain about the end of the 16th or early in the 17th century. It is largely used in Britain for decoration of avenues and for town planting. The special features of the Horse-chestnut are: seven sessile or very shortly stalked leaflets; erect conical clusters of white flowers internally tinged with pinkish-red, which appear in May; glossy dark-brown fruits, which ripen in October. Its white wood is soft, and neither strong nor durable as timber. See CHESTNUT, THE HORSE-.

Horse Clipper, a machine used for clipping horses' coats. See CLIPPING MACHINES.

Horse Dealer.—A horse dealer has been defined as 'a person who by his traffic distributes horses' (Oliphant's Law of Horses), or as a person who 'seeks his living by buying and selling horses'. Every person who exercises or carries on the trade of a horse dealer or of a livery-stable keeper, or who lets any horses for hire, or who keeps any horses to be used for drawing any public stage or hackney carriage, may make entry of his premises with the Inland Revenue authorities; and if he does so he is exempt from licence duty for servants employed by him at such premises in the course of his trade other than a servant employed to drive a carriage with any horses let to hire for any period exceeding twenty-eight days. There is not now any duty payable by horse dealers for carrying on their trade. See LICENCES. [D. B.]

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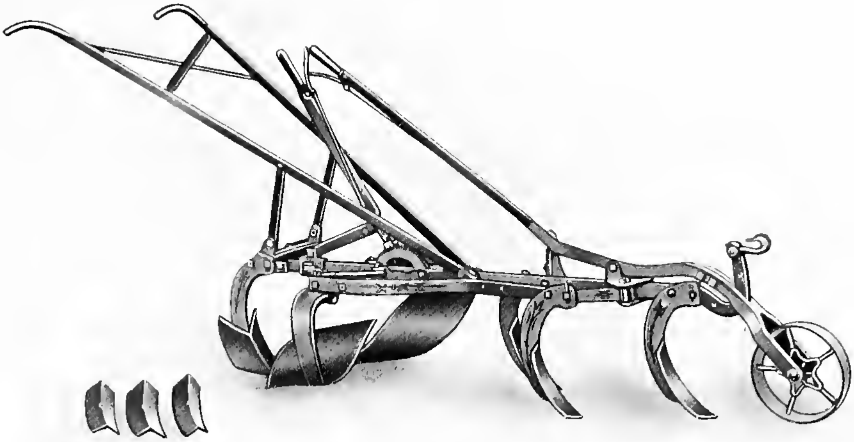

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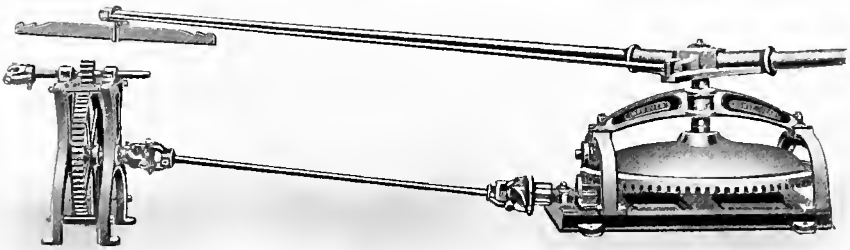


3

1, Horse Hoe (John Wallace & Sons, Ltd., Glasgow). 2, Horse Gear (R. Hunt & Co., Ltd., Earls Colne).
3, Nicholson's "Snapdragon" Horse Rake

Horse Dung. See Farmyard Manure.

Horse Gear.—A horse gear is constructed on lines somewhat similar to a windlass. A stout vertical axle is fixed to a frame, and is encircled by a revolving case, at the lower end of which is a large caged driving wheel; at the top provision is made to attach the shaft or shafts to which the horses are yoked. The driving wheel engages with a pinion wheel connected with a lay shaft, so that as the horses proceed round the circular horse walk the machine engaged at the distant end of the lay shaft is set in motion. Horse gears are still employed for many operations; but on large farms they are rarely used for threshing corn, as steam has long been proved to be most serviceable; sometimes, however, where a good plant has been set up, especially in somewhat inaccessible localities, threshing on a fairly extensive scale is done. The comparatively few instances where steam did not oust the horse gear for heavier work are, however, giving way to the more convenient oil engine or suction-gas engine. On comparatively small farms, horse-driven threshing mills are more frequently met with, though very rarely so in England, as threshing machines on hire are available practically everywhere. For light work, such as slicing or pulping roots, driving small chaff cutters, stack elevators, pumping, and grist grinding, a small horse gear is very suitable and economical; and as small gears easily portable can be obtained, they are convenient to move from one part of the farm to another as occasion demands. Small gears suitable for a pony to work a stack elevator, or any power up to four horses, or even more, are available; and by the aid of intermediate gearing high speed can be obtained. A one-horse gear is always handy on a farm, and where a stack elevator is used is a necessity. It is generally advisable to have an intermediate gear, so that more speed can be obtained when faster work has to be done; and for this reason there is an advantage in having an independent intermediate gear rather than a gear which accumulates speed from gearing on the frame. Except where the gear is required for slow work such as an elevator-driving, the accumulator may equally well be taken from the frame gear. Messrs. Hunt of Earls Colne have a very efficient triple-speed horse gear, and as the change wheels work from the same centres there is little trouble in changing them. The speeds are 48, 66, or 80 to one revolution of the horses in a two-horse gear. Motion can be communicated from the horse gear to other machinery by means of clutches or from an intermediate pulley. Where the pulley is used to work a number of machines, overhead shafting has to be set up. Messrs. Saunderson of Bedford have a special method of communicating motion to machinery without expensive overhead shafting and without belting. It has the further advantage that clutch pins (which have caused many accidents) are avoided. By a direct drive to the spindle of the machine there is very little wear on the brasses, and motion can be carried to any number of stories and work a series of machines in either one. This is effected by employing a vertical spindle running from the intermediate gear, and attaching at any convenient heights a pair of bevelled wheels, which transmit motion to a radiating arm at right angles to the spindle. This arm is encased in a safety tube, and engages with spring clutches. The radiating arm can work from any point of the bevelled wheel except where it is hindered by the stay, consequently any machines, such as chaff cutter, pulper, root slicer, cake breaker, grist mill, which are placed semicircularly on either floor may be engaged as desired, all that is necessary being to disengage from one and engage with another. This system greatly enhances the value of the horse gear for working food-preparing machines, and is well adapted to use with wind motors also. [W. J. M.]

Horse-hair Worm, a popular name for several hairlike threadworms, especially species of Gordius, which sometimes make their appearance suddenly in pools of water or in damp earth. They have been vulgarly misinterpreted since the Middle Ages as due to the transmutation of horse hairs into living worms. Many species of the genus Gordius (over 100 have been reported) are represented in ponds and ditches, and may be seen writhing among the water-weeds or swimming freely. Sometimes a number occur entangled together in a Gordian knot. The larval forms are parasitic in insects, and it is from the bodies of insects that the 'living hairs' in the pool have come. In the case of *Gordius tolosanus*, the first larval form is parasitic in the larva and adult of the Alder-fly (*Sialis lutaria*); this first host is eaten by a beetle (*Pterostichus niger*), and the Gordian larva passes into a second stage; from the beetle the adult emerges into the water about eighteen months after it was hatched. The genus Gordius is so divergent that it cannot be included in the class of Nematodes in the strict sense, but some of these are occasionally called 'horse-hair worms', *e.g. Mermis nigrescens*, a hairlike form which lives as a sexual adult in damp earth and as a larva in grasshoppers. It is sometimes seen in large numbers creeping up the stalks of cabbages and the like, and this appearance has been misinterpreted as due to a shower of worms. [J. A. T.]

Horse Hoe. See Hoes.

Horse-power.—The value of a working agent depends not upon the amount of work it is capable of doing, but upon the amount of work it can do in some given unit of time; *i.e.* upon its activity, or the *rate* at which it can do work. For example, if a man could pump 2000 gal. of water in one hour to a height of 10 ft., while a certain steam engine could do the same amount of work in one minute, the value of the engine, as a working agent, would be sixty times as great as that of the man. This *rate of doing work* is denoted by the term *power*, and in order to measure it we require some *unit power*. Unit power may be defined as *unit work done in unit time*, but as there are various units of work so also are there various units of power, such as: a foot-pound per second, a foot-ton per minute, an erg per second, a watt, &c.—a watt is the unit of power used in elec-

trical engineering, and is equal to ten million ergs per second, or the energy expended per second when an electrical current of one ampere flows through a conductor having a resistance of one ohm, or a difference of electrical potential of its terminals equal to one volt. The unit of power commonly used in this country, however, is a peculiar unit, called a 'horse power', established by James Watt, and which he introduced so that purchasers of his engines should be able to compare their values with those of horses. Watt found that the average horse in continuous work could do about 22,000 foot-pounds of work per minute, but to this he added 50 per cent and took 33,000 foot-pounds per minute as the unit of power; the extra margin being allowed to prevent any possibility of a mistake in the other direction. A horse-power, therefore, means energy expended, or work done, at the rate of 33,000 foot-pounds per minute, or 550 foot-pounds per second, or 1,980,000 foot-pounds per hour; and an electrical horse-power is equal to 746 watts, or work done at the rate of 746×10^7 ergs per second. To calculate, therefore, the horse-power of a working agent we use the formula—

Horse-power = work done in foot-pounds per minute ÷ 33,000, or

Electrical horse-power = number of watts ÷ 746 = current strength in amperes × difference of electrical potential in volts ÷ 746.

For example, if a waterfall deliver 6600 gal. of water (each of which weighs 10 lb.) per minute

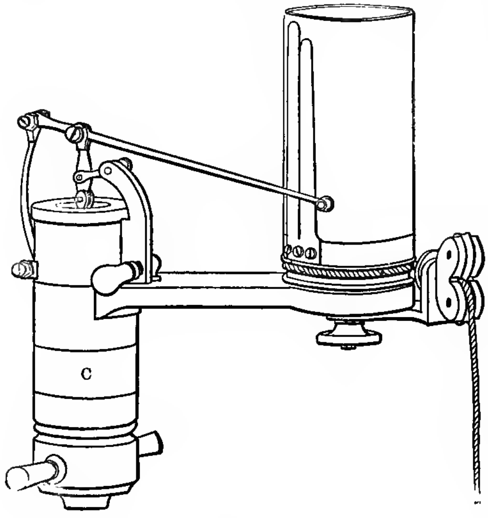


Fig. 1[1]

and the height of the fall be 100 ft., the horse-power of the fall would be $= 6600 \times 10 \times 100 \div 33{,}000 = 200$; or again, if a dynamo machine delivers current at a strength of 149·2 amperes with a potential difference of its terminals of 100 volts, the electrical horse-power of the dynamo would be $= 149{\cdot}2 \times 100 \div 746 = 20$.

[1] Figs. 1 and 4 are taken by permission from Ewing's Steam Engine (Cambridge University Press)

Actual or Indicated and Effective or Brake Horse-power.—The energy exerted by a machine is always greater, and sometimes considerably greater, than the useful work done, as a portion of the energy is always expended in overcoming frictional resistances. The horse-power exerted by a machine may, therefore, be called the *actual* power, whilst that corresponding to the useful work done may be called the *effective* horse-power.

In the case of a steam, gas, water-pressure, or

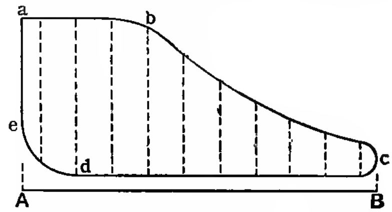


Fig. 2

other engine, the actual horse-power is determined by means of an instrument called an *indicator*, and is therefore called the 'indicated' horse-power. The essential parts of an indicator consist of a small cylinder (C, fig. 1), which can be put in communication with the engine cylinder by means of a cock. In this small cylinder there is a helical spring, attached at one end to a movable piston and at the other to the fixed cap of the cylinder, and through a hole in this cap the stem or rod of the piston projects. The top of the piston rod is connected by linkwork to a pencil in such a way that the pencil moves in a straight line parallel and proportional to,

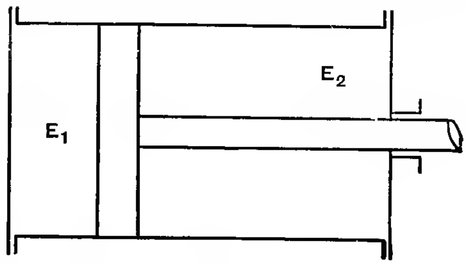


Fig. 3

but magnifies the motion of the piston. By means of the spring, as the pressure of the fluid in the engine cylinder rises and falls, the piston and pencil rise and fall proportionately; and at the same time the pencil point, pressing lightly upon a sheet of paper stretched upon a drum which is made to move transversely and copy faithfully the motion of the engine piston, draws an indicator diagram. For a steam engine the diagram, taken from one end, E_1, of the cylinder (fig. 3), may be of the form shown in fig. 2, where the line AB represents the datum atmospheric line, and the length of AB the length of stroke of the engine piston. During the forward stroke of the piston the steam pressure varies as represented by the ordinates to the

curve a b c, and during the return stroke the back pressure varies as shown by the curve c d e. The average breadth of the diagram is usually found by dividing the diagram into ten parallel strips of equal width and measuring the heights of these strips at the centres, as indicated by the dotted lines. The sum of these heights divided by ten will give the average breadth of the diagram. Suppose, now, that a pressure of, say, 30 lb. per square inch on the piston is represented by a height of 1 in. on the diagram, and that 1·5 in. is the average breadth of the diagram; then 30 × 1·5 = 45 lb. per square inch will be the average pressure on the piston. In the same way the average pressure can be found for the other side, E_2, of the piston, and if p be the mean of the two average pressures thus found, A the area of the piston in square inches, L the length of the stroke in feet, and N the number of strokes per minute, the indicated horse-power of the engine, neglecting area of piston rod, would be—

$$\text{I.H.P.} = p \cdot A \cdot L \cdot N \div 33{,}000.$$

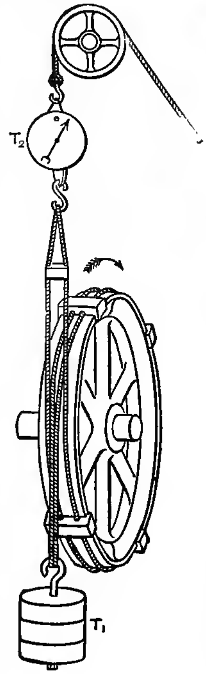


Fig. 4

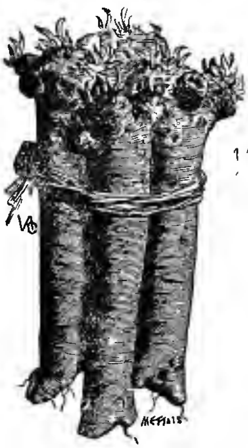
BRAKE HORSE-POWER.—The effective or brake horse-power of an engine, if not too large, can be conveniently determined by putting a *brake*, such as that shown in fig. 4, on the flywheel. The simplest method is to pass a double rope round the wheel, the rope being held in position by loosely fitting wood blocks as shown. To one end of the rope is attached a spring balance, and from the other end a load of W pounds, say, is suspended. If P be the pull on the balance, in pounds, and R the radius, in feet, to the centre of the rope, the frictional resistance overcome at the flywheel by the engine will be = W − P pounds; the work done per revolution will be $(W - P)2\pi \cdot R$ foot-pounds, and the effective or brake horse-power of the engine will be—

$$\text{B.H.P.} = \frac{2 \cdot \pi \cdot R(W - P)n}{33{,}000},$$

where n is the number of revolutions of the flywheel per minute, and $2 . \pi . R$ the circumference of a circle of radius R. The symbol 'π' represents a number, approximately = $3\frac{1}{7}$, which, when multiplied by the diameter of a circle, gives the circumference. The ratio of B.H.P. to I.H.P. is called the mechanical efficiency of the engine, and has a value equal to about 0·85, usually, for steam engines; in other words, some 15 per cent of the indicated power is lost in overcoming frictional resistances in the engine itself. [H. B.]

Horse Pox. See PUSTULATION.

Horse Radish.—This familiar hardy perennial (*Cochlearia Armoracia*, nat. ord. Cruciferæ), a native of Europe, now naturalized in Britain, has been cultivated for its roots from the earliest times, and is an almost essential accompaniment of the roast beef of old England. It will thrive under any sort of conditions, but fine roots can only be produced in deep, rich, and rather moist soil. A plantation is established by planting pieces of the roots 1 ft. apart at a spade's depth. In digging, it is customary to leave a portion of the root to furnish next season's supply, but it is best to make a fresh bed every three or four years. [W. W.]


Horse Radish

Horse Rake. See HAYMAKING MACHINERY.

Horse Shoes and Horse Shoeing.—The necessity of shoeing horses is now universally admitted, and all the attempts to substitute other methods for that of nailing on to the hoof have failed when put into practice. A now famous writer on veterinary hygiene has said: 'I am a believer in the rim of iron; there is no form of shoe which I consider superior to another'; but this is not the general opinion of practical horsemen, or of veterinary surgeons accustomed to prescribing shoes in which cripples can work. The rim of iron is, of course, the essential principle by which the crust is protected; but the chief evil of it is that it protects the sole, the frog, and the bars as well, so that these do not come in contact with the ground and receive the necessary compression and wear which are desirable for perfect health and functional activity in the foot. The rule that any organ not used must atrophy, applies to the foot, which is not an insensitive block, but a complicated and beautiful organism protected by an outer layer of insensitive horn, of which the crust is the hardest and the frog the softest, the sole being intermediate in density. Seeing that contact of the plantar surface with the ground is necessary for the perfect health of the foot, the ideal shoe would be one that permitted of an equal bearing everywhere while protecting the outer edge (crust) from being broken. M. Charlier thought he had discovered such a one when he introduced a thin narrow shoe, sunk into the crust by cutting out a groove. This shoe, or a modification of it with the heels cut off, is sometimes prescribed

for horses with contracted feet and wasted frogs, and if the initial tenderness it produces can be overcome, much and lasting benefit is derived. For general purposes, however, this form of shoe does not answer, and resort is had to the older and apparently permanent types. For agricultural and general labour, horses of heavy class are shod in plain stamped shoes. In cities, where stone setts are used, it is necessary to make calkins, or turned-down heels and toepieces of similar construction, to afford a foothold. The majority of heavy horses have a thick or wedge heel, or else a turned-down (calkin), as such shoes put less strain on the back tendons, and assist in starting and backing loads. Carriage horses are shod much lighter, and various patterns of iron are used: some with a single fuller, others with a double ditch, the idea being that more security or better foothold is obtained whether this depression is filled up with grit or not. The shoes of hunters are made narrow, single-fullered, short, and tapered off at the heels, with the object of avoiding suction in wet ground, and over-reach from behind. A little thickening of the heels of the hind shoes is permitted, especially when the subject is disposed to go up on the fetlock joints. Racehorses and polo ponies are shod in very light 'plates', as they are called. Hackneys are usually given heavy shoes, as these promote high action, so long as the animal is never allowed to really tire himself.

The number of nails commonly employed is three on the inside quarter, and four on the outside, distributing them according to the thickness of the wall, where a perfect foot and sound action favour the farrier; but many horses disposed to brush or turn out their toes (see Brushing and Interfering) may be made to go with five nails, two of which will be near the inside toe, and three on the outside quarter. The pritchel, by which the nail holes are punched, is wedge-shaped, and the nails correspond, so that their wear is the same as that of the shoe, and they retain it in position until worn very thin. They are carefully pointed in such a manner as to take an outward direction when driven; then turned back or clenched, and finally rasped or filed, so that a thin neck only holds the clench on the hoof and the shoe in its place. In good private studs it is a general instruction to remove the shoes every three weeks, and if not much worn they are put through the fire and refitted. Retention of the shoe is a fruitful source of corns and other injuries; but in the case of agricultural horses, the wearing of the shoe very thin affords during the latter period some of the much-needed frog pressure, and hence we find them to have sounder feet than those more frequently shod. The custom of cutting out the sole and trimming away the frog is now generally condemned, only ragged portions of frog or exfoliating masses of sole receiving a little assistance from the smith. The presence of hard masses affords desirable pressure, and prevents too rapid evaporation and contraction of the heels.

Bar shoes are prescribed for horses with separation between the crust and sole, and often assist where corns exist. Horses that have suffered from fever in the feet (see Laminitis) and have dropped soles, are shod with seated-out, wide-webbed shoes, affording much protection to the tender sole, yet by the 'seating out' having no bearing save on the crust, which is best able to sustain the weight. Horses suffering from navicular disease, or other foot troubles in which it is desirable to minimize concussion, may have a leather sole or a ring of felt or rubber under the shoe. A greater thickness at the toe also enables groggy horses to work better. For the study of curative shoeing, the reader is referred to the work of Messrs. Dollar and Wheatley, Horse Shoeing and the Horse's Foot.

A great variety of rubber pads on leather foundations, through which the nails are made to pass, are now employed to reduce concussion and afford foothold, but an exposed foot enjoys greater immunity from thrush. Screw cogs in frosty weather are preferable to frost nails, which soon wear down, or to sharp-pointed turned-down heels and toes, known as roughs or roughing. [H. L.]

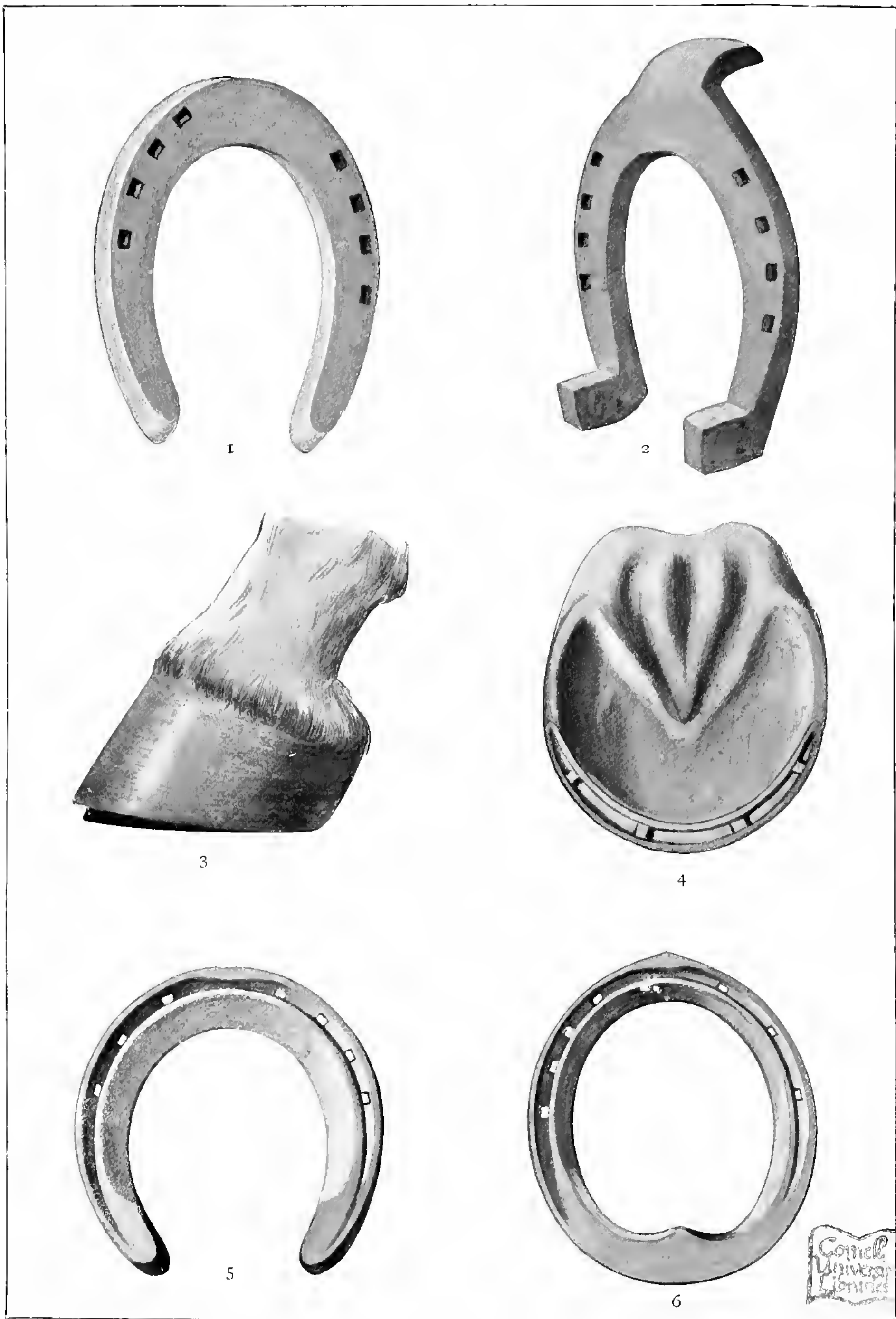
Horse Spider. See Hippobosca.

Horsetail, a perennial herbaceous weed which flourishes on marshy and wet soils. See Equisetum.

Horse Walk.—Horse walks, the circular tracks around which horses travel when turning a house gear, are sometimes made with considerable elaboration; and where much heavy work is done a covered walk is a decided advantage, not merely for the comfort of the horses, but as a protection to the track. The area to be covered in is, however, extensive, as the draught poles are usually 10 ft. in length, and the diameter is therefore 20 ft. at least, so the covering to the horse walk must be considerably more to allow working room; the height, too, must be sufficient to allow the horses freedom, and if the horses are harnessed to an overhead yoke, it must be higher than where the ordinary pole and whipple draught is used. The pad of the horse walk should be made of lasting material, as there is a large amount of wear in the track; railway sleepers make a good track, but any hard-wearing road metal found conveniently answers the purpose. [W. J. M.]

Horses, Breeds and Classification of.—For purposes of reference, horses may be classified under the three heads of Draught, Driving, and Riding. There are three draught breeds in the British Isles—the Clydesdale, the Shire, and the Suffolk. Between the first, which is indigenous to Scotland, and some families in the second, which takes its name from the English shires — that is, the midland counties of England, in particular Derbyshire, Lincolnshire, and the Fylde district of Lancashire—there are various points of resemblance, yet outstanding points of difference. The Clydesdale is the more active, has cleaner, flatter bones, better shapen feet, and a better laid and more oblique shoulder. He is excelled by the Shire in roundness of barrel and firmness of back; so that Shire yearlings and two-year-olds usually look bigger, and are in reality bigger, than Clydesdales of the same age. Shires on the scales may outweigh

HORSE SHOES



1, Stamped Fore-shoe for cart horse for farm work. 2, Hind-shoe for cart horse for town work. 3, Hoof prepared for Charlier tip. 4, Charlier tip applied. 5, Fullered Fore-shoe dished in ground surface, for carriage horse. 6, Concave Bar Fore-shoe for hunter.

Clydesdales, and they are well suited for the purposes for which they are commercially bred, the heavy dray work of the chief English towns. Yoked as they often are, three, four, and six in railway contractors' heavy wagons and in brewers' drays, they are able to put their own weight avoirdupois against the weight of the loaded wagons, and to move at a comparatively slow walking pace. The Clydesdale, on the other hand, is bred commercially to go between the shafts of the single-horse lorry to be found in Scotland and the north of England. For this purpose, sheer weight avoirdupois is of less importance than spirit, energy, and sagacity. Consequently the two breeds have gradually been evolved not so much in respect of essential differences, as of a varying emphasis on characteristics which render them more useful for the commercial work in which they have to be engaged. The Clydesdale is more spirited and less phlegmatic than the Shire; he carries less hair on his legs, and the formation of his head and hindquarters is distinct from the formation and hindquarters of the Shire. An exceptionally good work horse for street traffic is got by blending the two breeds. As a farm horse, the Clydesdale excels. The prevailing colours in Clydesdales for wellnigh half a century have been bays and browns, with an occasional black. The prevailing colours in Shires are now also bays and browns, but in the early days of the London Shire or Cart Horse shows (1880–90), chestnuts, greys, roans, and blacks were almost, if not quite, as common as bays and browns. The Clydesdale has almost a monopoly of the Canadian export market. Up to 1882 it also had a practical monopoly of the United States market, but in that year Shires began to be exported to the United States in increasing numbers, and possibly they now hold a firmer grasp of the American market than the Clydesdales. Both British breeds have there to wage a strenuous battle with the Percheron, or French draught horse. This is by far the most popular draught breed in America (as distinguished from Canada). In outline, the Percheron is not unlike the English Suffolk, but is more proportionately built. The universal colours in Percherons are either greys or blacks. They are clean-limbed horses, without any fringe of hair on their legs. They have usually good feet and well-sprung pasterns, and they are very active horses. The best draught horses for street traffic seen in America are said to be the cross between the Percheron and the Shire or Clydesdale. The Suffolk is an absolutely distinct breed, indigenous to East Anglia. The prevailing, indeed universal, colour is sorrel or chestnut. The breed is characterized by great weight of body and depth of rib, with clean limbs, rather out of proportion to the weight of the body. They have good action, and are well known in the London streets for their fidelity in a dead pull, where they may be yoked three, four, and six in a wagon or dray. As farm horses, the Suffolks with their clean limbs are well adapted for work on the heavy clays which prevail in East Anglia. There is a certain general resemblance between the Suffolk, the Percheron, and the Belgian draught horse which suggests that at some remote period they sprang from the same stock.

Of Driving or Harness horses there are in Great Britain three outstanding varieties or breeds—the Hackney, the Cleveland Bay, and the Yorkshire Coach-horse. The first-named is indigenous to Norfolk, where it was originally known as the Norfolk Cob. It was improved probably by the use of the Thoroughbred and by selection in Yorkshire, and within recent years some of the choicest specimens of the breed have been foaled and reared in Scotland mainly from Yorkshire blood. The Hackney appears to have been developed by selecting for harness purposes members of the same race of horses as formed the English Thoroughbred. He is essentially the Park driving horse, with high knee-action, and a peculiar quality of hock action which is at once 'high' and has in it what is known as a 'dwelling' note. There is something unique in the all-round high action of a true Hackney. It has been said that the first point in a Hackney is 'action', the second point is 'action', and the third point is 'action'. The prevailing colours among Hackneys are dark chestnuts, whole-coloured browns and bays, with an occasional lighter chestnut, and sometimes, during the past ten or twelve years in particular, an undue proportion of white markings. The Cleveland Bay lost caste to a large extent after the decay of coaching. He was the English coaching horse—heavier than the Hackney, and showing less trace of Thoroughbred blood than the Yorkshire Coach-horse. The latter may be described as a result of crossing the Cleveland Bay with the English Thoroughbred in order to produce a horse of greater refinement than the Cleveland Bay for heavier private carriage work. Other three driving breeds have from time to time attracted considerable attention in this country —the Orloff or Russian Trotter (mostly greys, and very fast), the American Trotter (bred for speed at a trotting gait and nothing else), and the Oldenburg or German Coach-horse, which enters into rather sharp competition with the Yorkshire Coacher and Cleveland Bay in their own departments.

All Riding horses and even riding ponies in Great Britain and Ireland are descended from the English Thoroughbred or racehorse. Ireland is the great source of supply for Hunters, and so jealously is the Thoroughbred purity and descent of the Irish Hunter guarded, that in some districts in Ireland nothing but Thoroughbred sires are tolerated. The English Thoroughbred is undoubtedly the fountainhead of all good riding stock. The Hunter Improvement Society is labouring hard to produce Hunter sires, and has achieved a measure of success. The Riding Pony Society is engaged in like work, and the Riding or Polo pony is at his best according as he has more or less Thoroughbred blood in his veins.

See under separate headings for each of the breeds and varieties named. [A. M'N.]

Horses, Imports and Exports.—The foreign trade of the United Kingdom in horses

amounts in the aggregate to a considerable sum, representing in 1907 about $1\frac{3}{4}$ million sterling. Of this nearly half a million was for horses imported, and $1\frac{1}{4}$ million for horses exported. The growth of the trade is indicated in the following summary, which gives the average annual number and value in quinquennial periods down to 1905, with the figures for each of the two last years added:—

	Imports.		Exports.	
	No.	Value.	No.	Value.
1861–65	1,541	£38,303	4,310	£238,566
1866–70	1,785	45,369	4,343	187,239
1871–75	14,336	505,905	3,924	216,297
1876–80	24,541	713,528	3,727	245,579
1881–85	11,028	219,643	6,792	416,036
1886–90	13,458	238,699	11,768	714,567
1891–95	22,666	540,807	14,987	541,951
1896–1900	45,760	1,184,401	34,502	824,310
1901–05	26,602	674,913	35,608	797,007
1906	17,848	535,532	61,673	1,349,893
1907	15,922	429,549	61,783	1,240,823

The sources from whence horses are now sent to the United Kingdom are not very numerous. In 1907, out of a total of 15,922 no less than 9102 came from Russia, while Iceland sent 2461. Of the latter, 153 were stallions. France sent 1434, of which no less than 876 were stallions, while Belgium supplied 357, more than half of which were entire. From Holland 915 horses were shipped to this country during the year, and the United States sent 786, Argentina 432, and Canada 166. Large numbers of the imported horses are no doubt of low value, those from Iceland, for example, probably not more than about £5 per head, and from Russia about £11 per head; but on the other hand there are a considerable proportion of valuable horses, which raised the general average per head to £27.

A certain proportion of the horses imported into this country, including many of the most valuable, are not retained here, but are again exported. In 1907, for example, 1400 foreign horses were re-shipped to other countries, their average value per head being £80, and in the previous year nearly as many were thus disposed of, at an average value per head of £115.

The export trade in British and Irish horses consists, broadly speaking, of two classes, viz. those which are worn out and are sent abroad for slaughter, and those which are intended for breeding purposes or for use. Of the total number exported in 1907 about 30 per cent were valued at less than £5 per head, and 47 per cent were valued at between £5 and £10 per head. Nearly the whole of those at the lowest price went to Holland, while Belgium took the large majority of those at between £5 and £10. At the same time, both countries also took a considerable proportion of the more valuable horses, no less than 3301 horses valued at £20 and over going to Belgium, and 1708 of the same class to Holland. France took 2233 at an average value of £45, Germany 1421 at an average of £44. As a rule, however, the trade in the best horses was largely with more distant countries. Japan, for example, purchased 60 at an average of £450 apiece, Chile 35 at an average of £178, Argentina 416 at an average of £124, and the United States 993 at an average of £65. Some of the most valuable shipments were made to other parts of the empire. Thus Australia bought 110 at an average of £166, and New Zealand 17 at an average of £312. South Africa bought 122 at an average of £140, in addition to 60 at £126 apiece for Natal. Canada was by far the largest purchaser among our kinsmen oversea, no less than 1690 horses being sent to the Dominion in 1907 at an average of £57. India took a much smaller number, but of good class; 118 at an average of £176 being sent to Bombay, and 30 at an average of £165 to Bengal.

Alarm is sometimes expressed at the magnitude of our export trade in valuable breeding horses, and it is feared that our home stock may deteriorate in consequence of the loss of many of our best animals, and especially mares. Of the total number of home-bred horses exported in 1907, 6379 were mares and 1548 stallions. The annual crop of foals in the United Kingdom is about 200,000, so that in actual numbers it cannot be said that the drain of the foreign trade is a very serious one on our horse-breeding resources. It is no doubt true that many of the best go abroad, but it must be remembered that the foreign and colonial demand is in itself an incentive to home breeders. The wider the market for the best animals, the more good animals will be bred. If the market were suddenly restricted by the cessation of the overseas demand, it is evident that the inducement to breed horses would be to that extent diminished. While, therefore, it appears not unnaturally to be a cause for regret that so much of our finest breeding stock should be lost to us, it is well not to overlook the fact that the existence of the export trade is, in a broad sense, of great advantage, not only to individual breeders, but also to the maintenance of the horse-breeding interest in the United Kingdom. [R. H. R.]

Horses — Rearing, Feeding, and Management of. — The care of the foal for the first few days after birth is a matter of great importance, and to a want of knowledge on the subject is attributable a large proportion of the heavy annual loss which occurs. Strict attention should be paid to the action of the young animal's bowels, which are frequently constipated; and a mild laxative, such as castor oil or butter, is often necessary to assist the expulsion of the hard, dry 'meconium', which has been accumulating in the terminal part of the bowel for some time before birth. The first milk which the mare secretes after parturition has special laxative properties; but not infrequently we require to assist this (more particularly in the case of foals which have been carried for some time beyond the natural period), and even to remove the hard fæces from the foal's bowel after giving an enema of soap and tepid water or glycerine and water. The occurrence of constipation in the foal is evidenced by straining and the absence of fæcal matter;

this, if neglected, may rapidly develop into inflammation of the bowels and cause death.

Another common source of the high mortality in foals is 'navel ill' or 'joint felon', a disease undoubtedly due to bacterial infection of the unhealed navel cord, causing a form of blood poisoning, and frequently traceable to want of cleanliness in the loose box, the navel becoming infected when the foal is lying. This is certainly an instance of a disease in which prevention is better than cure, for severe cases nearly always terminate fatally, and even if the foal survives, he is of little use. Some districts, and more particularly some farms, are noted for the prevalence of this disease, and it is probable that the soil itself contains the germs of infection. The foaling box should have a stone or brick floor, and must be kept scrupulously clean. The walls should be limewashed, with the addition of a disinfectant such as carbolic acid, before the birth of the foal occurs, and the floor thoroughly swept out and then washed with water to which a disinfectant has been added. Immediately after parturition all the cleansing, blood, liquid, &c., should be carefully removed, along with the soiled bedding, and a clean, plentiful bed of straw laid down. There are grounds for believing that in some instances 'navel ill' originates by the foal sucking bacteria from the unclean udder of the mare, and this can be prevented by sponging the outside of the vessel with a mild disinfectant (such as Jeyes' fluid and water) just before or immediately after the foal is born.

Opinions differ as to whether or not the foal's navel should be ligatured at birth, and certainly the disease occurs under both conditions. Provided the cord is severed with a sterilized instrument and a clean tape used as a ligature, then the writer would recommend this being done; but unless strict asepsis can be maintained it is preferable to refrain from interfering. The remains of the cord should be smeared over with a disinfectant twice daily until it drops off, and more particularly if the foal is housed, or if the weather is hot and flies numerous.

The germs of tetanus or lock jaw, which are widely distributed in soils and manures of certain localities, may also gain an entrance to the system by the unhealed navel, and cause death in a very short time.

Provided the foal escapes the maladies previously mentioned and safely reaches the age of one month, then in all likelihood he will thrive and grow fast during the summer, when he is allowed to run by his mother's side, provided she is a good nurse. Attention should be given to note if the mare is milking well, and if not, have her changed to the most succulent pasture or foggage, so as to encourage the secretion. Some mares tend to put on flesh instead of yielding milk, and to this the condition of the foal should be the best index. It is advisable to allow the foal to remain with the mare till about five months old, and he should be taught to eat food before he is weaned. Neglect of this precaution explains how frequently newly weaned foals become so reduced and thin, and as a result are so difficult to bring through the first winter.

For a few days after separating the foal from the dam it is advisable to keep him in a loose box or shed, and if there are two or more foals they settle much quicker. The feeding may consist chiefly of cut grass, and a little bran and bruised oats, given at first very sparingly. It is a mistake to turn recently weaned foals into rich pasture right away, as they are liable to gorge themselves and cause impaction or even rupture of the stomach. Let the digestive organs have a limited supply of food to cope with, until they adjust themselves to the altered conditions of life and gain strength to deal with rich and bulky food.

The wintering of foals is more difficult than wintering yearlings or two-year-olds. They need more attention and care, and more food in proportion to their size, and often with it all they become ragged and unthrifty looking. Once they get really reduced and debilitated they rarely recover form until the following summer when the grass returns. In most parts of Scotland it is necessary to house them at nights, and they should be fed twice, or better still, three times, daily. Except when the weather is very cold and wet, or the snow lying deep, they are much better running out during the day, not so much for the food they pick up, as for the exercise, which is so essential for the growth of the body and the welfare of their limbs. Nothing is so productive of alterations in the joints and other structures of the limbs as overconfinement.

Quite a number of foodstuffs may be utilized as winter diet for young horses depending on what the farmer has on hand; bruised oats and bran, cut hay and pulped turnips moistened with treacle and water make an excellent mixture. If it is convenient to give hot food (which is much appreciated in the cold evenings), an appetizing mash of boiled barley, turnips, beans, bran, and cut hay is productive of good results. In addition, long hay should be supplied in the evenings, so that the foals are ensured against too long a fast during the night.

When the spring comes round again and the weather becomes milder, the yearling may be turned out, but should still have a feed night and morning in the field until the grass is well in evidence. In the following autumn the yearling can be left lying out a little later than the previous year without detriment, provided the weather is at all seasonable, for he is now more vigorous; and when brought into the loose box his diet should be much on the same lines as in the previous winter, although it will usually be found he is easier to feed, requires less attention, and keeps in better condition than formerly.

Pedigreed valuable stock are as a rule allowed to run free until they are three off; but the small farmer cannot afford to do this, and as a result the colt in the winter of his second year is put to light work, such as ploughing on red land or stubble. He should be gradually introduced to this work, and not allowed to do more than half a day every second day at the

first,—in fact, half a day is quite enough for the youngster to attempt the first year. It is most important to have him yoked with an old, steady companion, and to put him to work on the level land—not in the furrow; as he is liable to twist about, tramp his hoof heads, or as frequently strain the muscles of his shoulder in the uneven walking, and thus become lame from the condition popularly termed 'shoulder slip'.

As the spring advances he may be put to the chain harrows, and when seedtime is past it is advisable to turn him out to the grass for another summer. When he comes up in the autumn he is introduced to the more serious work of the farm, and broken to the cart and other similar work. It is well to bear in mind, when handling young animals, that overwork must be avoided at all costs. The bones, ligaments, and joints are soft and lack maturity; consequently if called upon to endure excessive strain they soon show the effects, and knuckling over at the fetlocks, bending at the knees, and other defects soon become apparent.

FEEDING.—No attempt can be made to deal with this matter in detail, we can only glance at the general principles involved. Looking at the matter from a plain, practical point of view, a horse must be considered as a machine out of which it is desired to attain the greatest amount of work at the smallest expense and the least risk, in the same way as a cow may be regarded as a milk-making and breeding machine.

The food given must meet several requirements: it must be wholesome, abundant, clean, and sweet; the hours of feeding regular; and the quantity given should be proportionate to the size and arrangement of the digestive organs, and cleanliness in preparation should be observed. The stomach of the horse is very small, and it performs its function best when it is two-thirds full; hence we can understand that an animal should not receive bulky food in the intervals of work, and, what is even more important, he should be fed frequently, if possible not more than five hours being allowed to lapse between meals. It is also advisable to water the horse before feeding, as by so doing the water passes into the large bowel, and the stomach being empty none of the contents are washed out into the intestines. However, some horses have a rooted objection to drinking before feeding, similar to what we observe in the human being, and after all, it is questionable if much harm is done by watering horses after feeding. If horses are called upon to do work, especially severe work, when the stomach is loaded, then broken wind and asthma are prone to develop, owing to the pressure exerted on the lungs by the distended abdominal organs. This explains how often broken wind occurs in horses which are greedy feeders and consume bulky food. Work should not be too prolonged, or exhaustion soon occurs. After severe exertion the appetite must be tempted, especially as very often all ordinary food is refused; warm gruel may be given and a good bed provided, for frequently the appetite does not return until after a thorough rest. Colic is a common result of over-exhaustion, and more especially if the horse has received a full meal when in an exhausted condition. In this case the stomach has not strength to cope with the food, and acute indigestion, fermentation, and production of gases is the result.

It is advisable to give the farm horse a fairly liberal supply of hay for consumption during the night; it gives him something to do, and keeps him quiet, for the horse, unless very tired, is a light sleeper, and is frequently on his feet during the night watches. It is impossible to keep up vigour on concentrated foods alone; a certain amount of bulky food is needed by the bowels for the due performance of digestion; without it, the horse becomes 'tucked up', and some authorities believe it to be a common cause of 'crib biting'. Although the farmer, as a rule, feeds his horses on long hay, this custom has been largely discarded by commercial firms, and only the wealthy practise this form of waste. Unless the hay rack is carefully constructed, quite a quantity becomes pulled out, trampled under foot, and ultimately used as litter. Cut hay is much more economical; it ensures the thorough mastication of the grain ration mixed with it, saves the horse's time masticating it, and the quarter of the waste is prevented. Sudden changes in diet should be guarded against; horses fresh from grass must be brought gradually on to the usual stable diet, else an attack of laminitis or founder in the feet, or the so-called weed or 'lymphangitis', may ensue. In the same way, animals which are intended to be 'turned out' should have their corn ration reduced, and, if possible, get cut hay and grass mixed, for a couple of days previously; they should not be turned out hungry on to rich pasture, or a severe and fatal attack of colic or 'tympanitis' is liable to occur. The necessity of increasing or reducing the corn ration to correspond with the work performed is another point of practical importance; and the careful stud manager appreciates the necessity of light diet and exercise for the vigorous, idle horse, knowing full well that swollen legs, weeds, or 'Monday morning disease', or even the dire and frequently fatal 'azoturia', may follow in the wake of enforced rest and rich feeding. Beans added to oats will produce the most highly nitrogenous and stimulating diet a horse can assimilate. Where a reduction in diet is required, mashes of bran are substituted for the whole or part of the corn ration. [J. R. M'C.]

Horticulture is the cultivation of plants in gardens for use or ornament, as distinguished from their cultivation in fields (agriculture), or in plantations or woods (sylviculture), or in forests (forestry). The methods of the horticulturist or gardener differ from those of the farmer and forester in being, as a rule, more artificial than theirs, and the conditions he supplies are often far less natural. Gardening is now a highly developed art, based upon experience and observation extending over many centuries and applied to the production of flowers, fruits, &c., of high quality. By breeding, selecting, forcing, retarding, pruning, grafting, and the use of various appliances and plant foods, the gardener can accomplish much that would be

impossible without his art. The improvement of fruits and vegetables is due as much to the skilful application of heat, moisture, light, soils, and manures, as to the art of breeding and propagation; and the successful cultivation, by means of artificial conditions, of many kinds of plants which when wild have climates of their own, is rendered possible by the application of the art and science of horticulture. The management of an ordinary garden entails little more skill than is needed for the management of an ordinary farm. A knowledge of the main principles of horticulture and a few years' practical experience are sufficient to enable one to conduct the various operations necessary. The plants can be obtained ready-made from the nurseryman, or the seeds from the seedsman, and with the aid of a reliable book, such as the Gardener's Assistant (The Gresham Publishing Company), their treatment is easy enough. But the scientific pursuit of horticulture is quite a different matter. Experiments in crossing, in methods of propagation, in the application of heat and moisture, in the effect of light, and the numerous other operations and conditions which influence the growth and productiveness of plants, are always being made by gardeners advanced in their art. The conditions in which plants are found in nature are not always those best suited for their development along the lines preferred by the cultivator. Fortunately, plants are often sufficiently adaptive to enable them to thrive under a new set of conditions. The progressive gardener is ever on the watch for indications in the behaviour of the plant which will serve as a guide to its better treatment. Gradually a complete set of conditions is worked out, and then the horticultural treatment necessary for its successful cultivation is an accomplished fact. The method of the breeder is to seize upon some slight variation in form or colour, and apply his skill to its fixing and improvement; or by crossing two plants possessing certain characters he succeeds in producing in their offspring a combination of the two, which is then perpetuated by means of cuttings, grafts, or layers.

It will be seen that the difference between farming and gardening is only one of degree, the gardener's methods being as a rule more artificial and intensive. Market gardeners may be said to be farmers who apply horticultural art to field culture, and thus obtain larger results than those obtained by the farmer. How far the latter might with advantage follow the example of the horticulturist it is difficult to say. Certainly the profits of the most successful market gardener do not exceed those of the farmer. For small holdings horticultural methods ought to be preferable. This means the thorough breaking up of the soil to a depth of 2 ft., attention to drainage, the liberal use of manure, and the careful selection of crops suitable to the district and soil. The best sorts, whether of fruit, vegetables, or flowers, should be secured, and their treatment be of the most skilful character. In some districts it would pay to erect houses or frames and grow such fruit and vegetables as would find a ready market. The fact that prices are governed by supply must not be overlooked if the crops are to be profitable. It is possible to produce the best quality, and then, owing to competition, to be unable to realize a profit. The products of horticulture are no more lucrative than those of other industries. It would not be difficult to grow in this country a ten times greater quantity of garden fruits, vegetables, and flowers than is obtained annually now, but it is doubtful if the growers would be able to get prices that would repay them. The requirements of the various garden products are dealt with in this work under their respective heads.

Horticulture may be a desirable pursuit irrespective of its commercial aspect, and in that case there is no more delightful occupation. The cultivation of plants for home use, whether to serve as food or decoration, or to furnish the garden with objects of interest and pleasure, is the perfection of gardening. A well-appointed establishment, with its greenhouses for flowers and choice fruits, its fruit and vegetable garden for the staple food products, and its lawns, borders, flower-beds, and trees, and most important of all, workmen skilled in the art of gardening to make it a success, is a very important part of the home of the well-to-do Britisher. There is no country in the world where the art of the gardener is so highly developed as in the British Islands. This is due partly to the generally favourable conditions of the climate and soil, and partly to the inherent love of the Britisher for the garden and its contents. The chief reason, however, is the ardour with which horticulture has been and is pursued by those who have made it their profession. The British gardener's methods are followed in every country where high-class horticulture is aimed at. Not only is there a great army of practitioners, but there is also in this country a horticultural literature which plays a most important part in fostering a love of the garden, and in educating its adherents in the art of cultivation. See also arts. GARDEN; GARDEN COTTAGE; GARDEN SCHOOL; GARDENING LANDSCAPE; GARDENING FOR WOMEN. [W. W.]

Hose.—This is almost an essential in the well-ordered garden,—at least, where there is not a sufficient force of water to permit of its use the labour of watering is greatly increased. Hose coated with rubber is almost universally employed, and in the long run it is economical to purchase the better qualities; it is also advisable to use hose of as large diameter as circumstances permit. What is known as wire-armoured hose should be used in stony places. Where flower-beds and lawns have to be watered, a lawn sprinkler is of the greatest use, and of these the revolving pattern is the best. Hose is also generally used for watering in large greenhouses; the operation cannot be so nicely performed as with a can, but market growers prefer hose on the grounds of economy. [W. W.]

Hot-air Engines.—The term 'air-engine' is used to denote an engine in which the working substance is atmospheric air, and such engines have been constructed in the past of considerable size and power. About the middle of last century an air-engine was constructed by Captain

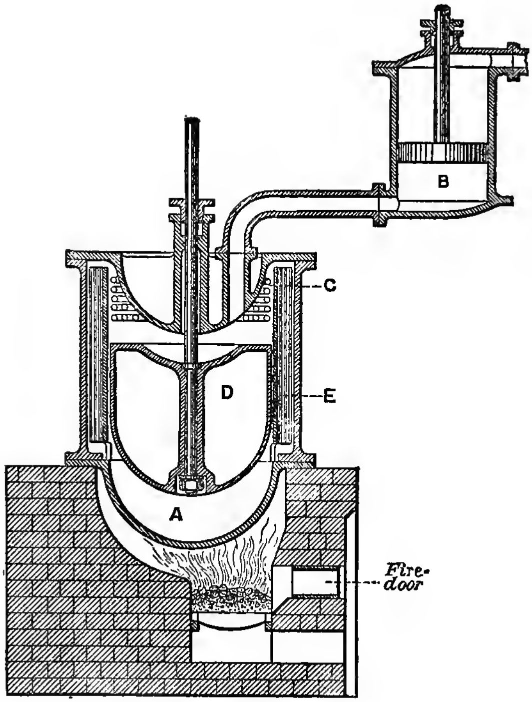


Fig. 1.—Stirling's Air-engine[1]

Ericsson, of America, having four cylinders each of 14 ft. in diameter, a stroke of 6 ft., and an indicated horse-power of 307; and another—a Stirling air-engine—of 50 indicated horse-power, was at work at the Dundee foundry in 1843. The principal features of this latter engine are shown in fig. 1. A is a large cast-iron vessel containing compressed air, a displacer plunger, D, an annular lining of wire gauze, E, called a regenerator, and a coil of pipes, C, through which cold water is circulated by means of a pump. The action of the engine is as follows: Starting with the plunger D at the top of its stroke, the bulk of the air is then in the space A below D, and is receiving heat from the furnace through the bottom of the heater. The pressure rises, therefore, and the air expands, thus causing the piston on the working cylinder B to be driven upwards. The plunger then descends, driving the air through the regenerator E, where it deposits heat and becomes cooled, into the upper and much cooler part of the heater A. The pressure of the air is thus reduced, and the working piston then makes its downstroke. Finally, the plunger is raised, driving the air from the upper part of the heater through the regenerator, where it takes up the heat it previously deposited there, and becomes heated and raised in pressure in the lower part. In this engine the working cylinder was double-acting, another heating vessel, exactly like A, being connected to the top of the working cylinder B. Further, the engine was supplied with compressed air, this being an essential condition for an engine of even moderate power; and in the example referred to, the pressure of the air varied from 160 lb. to 240 lb. per square inch.

Large air-engines have the great disadvantage of being excessively bulky in proportion to their power, and, in addition, the heating vessel always gives considerable trouble, consequently they have been superseded by steam, or gas engines, so that air-engines are now employed only for very small powers—from about $\frac{1}{8}$ of a horse-power to about 3 horse-power. A modern type of air-engine, used chiefly for pumping water for domestic supply, is shown in fig. 2. In this engine, D is the plunger, H the regenerator, C the piston, and E a water jacket surrounding the cylinder A, and the action of the engine is as follows: In the position shown in the figure, D is rising and C is just beginning to rise. The air in G, receiving heat from the furnace, expands and drives the plunger D upwards, and also does work upon C. When D reaches the top of its stroke, C is abou‸ halfway up, and the air,

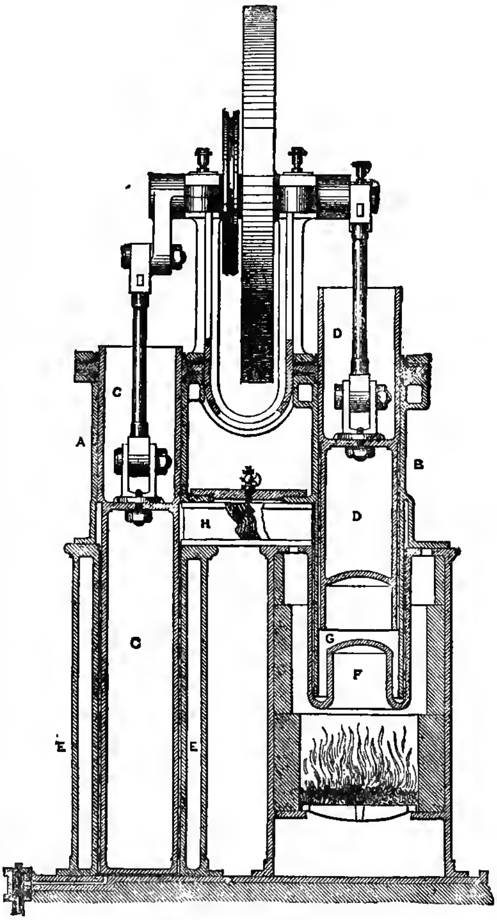


Fig. 2.—Rider's Hot-air Engine

[1] Figs. 1 and 2 are taken by permission from Ewing's Steam Engine (Cambridge University Press).

which is then passing through the regenerator from G to the space below C, becomes cooled, first by depositing heat in the regenerator and then by the water jacket E. The pressure thus falls, and continues to fall until the piston C begins to descend, when it does work up the air, compressing it and forcing it back again through the regenerator H, where it takes up the heat it deposited there, into the space G below the plunger. The air is thus already heated as it enters the space G; more heat is supplied to the air, however, from the furnace, and the cycle begins again.

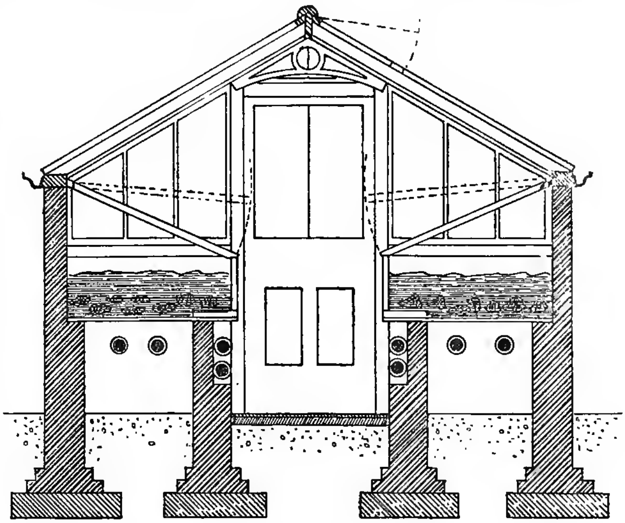
In these small air-engines, the only kind which are now constructed, the average pressure is only slightly above that of the atmosphere, and the maximum rarely exceeds 20 lb. or 25 lb. per square inch, so that the power they develop is very small.

[H. B.]

Hotbed. — The method of supplying heat to plants by fermenting materials is to a considerable extent superseded by the employment of hot-water pipes, which, wherever practicable, may generally be said to be more advantageous; but, on the other hand, for the production of early vegetables, and in small gardens, it would be well were hotbeds more extensively used. Prominent among their uses is that of supplying the moist heat required for the growth of cucumbers and melons, and the propagation of bedding and other soft-wooded plants from cuttings in spring; and in this respect they are superior to fire heat. Fresh stable litter should be mixed with an equal quantity of newly collected leaves and afterwards re-turned frequently, water being added if the heap is too dry. Three feet of well-trodden material is the most usual depth for a hotbed, and in calculating the required dimensions a margin of 3 ft. on all sides additional to the frame which will be placed on top should be allowed. Care must be taken not to introduce plants until the first rush of heat has subsided, and after doing so a little constant ventilation is generally required. A greater degree of heat is obtained by the use of litter alone, but the addition of leaves is to be recommended as increasing the duration of the bed.

[W. W.]

Hothouse. — This term is applicable only to a glasshouse in which a considerable heat is artificially maintained almost throughout the year. A gardener understands the word greenhouse (which see) as indicating a structure in which the temperature is always moderate, while the occupants of a stove or hothouse are tropical plants subjected to a high temperature all the year round, and the term intermediate house is self-explanatory. Whatever the form of a hothouse may be (that with a span roof is to be preferred), it must be remembered that to thrive plants require light, and in all hothouses the arrangements for ventilation must be ample. If there are not side sashes which open, there should be openings in the side walls fitted with hinged shutters in frames, and it is a great convenience if the ridge lights are fitted with gear to obviate their having to be opened and closed separately. Adequate arrangements for heating are, of course, a necessity, and heating by means of hot-water pipes is now universal. Of the variety of types of boiler upon the market, the plain saddle boiler or some modification of it continues to be widely employed, tubular boilers, though in favour in large establishments, having the defect of being occasionally liable to get out of order. Four rows of 4-in. pipes are sufficient to maintain ordinary temperatures in



Section of Propagating Pit

a house 12 ft. wide, but five or six rows are needed in a stove or propagating pit of this size; these should be fitted with evaporating troughs, and the water tank should have pipes passing through to warm it. The expedient of bottom heat, which means that plants are grown or plunged in beds with pipes running through them, is often resorted to, and a propagating pit contains glass cases to facilitate the rooting of cuttings inside. In selecting plants for hothouse cultivation it must be remembered that they are very variable in their requirements. Where hothouse accommodation is limited, care must be taken to select only those that are suited by the same conditions; but where a considerable collection is required and only one structure is available, the difficulty is often surmounted by providing a partition in the house. Shading is another requirement of the hothouse, and this is best afforded by means of canvas blinds mounted on rollers.

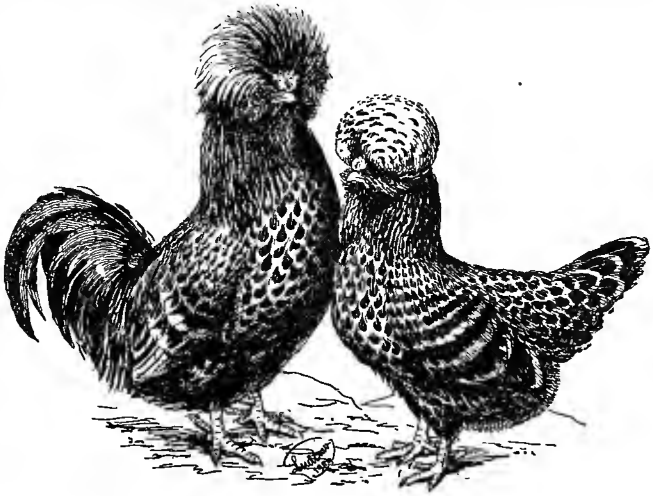
The successful management of a hothouse requires experience and a good deal of skill. Harm is often done by the maintenance of excessive temperatures in winter. This deprives plants of

the period of comparative inaction which is beneficial to them, and promotes an unhealthy growth. A night temperature of 60° to 65° F. in winter is sufficient for the stove, with an increase of 5° to 10° during the day; a higher temperature is permissible in spring, but care must be taken that sudden bursts of sunshine, which rapidly raise the temperature, do not injure the plants. From May onwards, 70° is a safe temperature at night, and it may rise to 90° during the day. An intermediate house is generally maintained about 10° lower than a stove. Air must be admitted on the side opposite to that from which the wind blows, and while it may generally be said that plants in hothouses are apt to suffer from insufficient ventilation, it must also be remembered that cold draughts are capable of working great harm. Watering is a matter of which a complete understanding can only be gained by experience. Soft-wooded plants require the most water; and while the idea that those of any kind should be watered at stated intervals is quite a mistaken one, it must be remembered, however, that it is exceedingly harmful to allow tender plants to get thoroughly dry. [w. w.]

Hot-iron Test.—This is perhaps the simplest and most reliable test applied in Cheddar cheesemaking for ascertaining the acidity or fermentation in the curd. It originated in America, and was introduced into this country by American instructors. A small sample of the curd, having been firmly pressed in the hand, is applied to a hot iron which is just sufficiently warm to roast the curd without charring it, or to cause it to give a dark-brown incrustation on the iron. When applied lightly and removed very gradually, the curd forms fine silky threads stretching out from the iron. Acidity has the effect of partially digesting the casein of the curd so that it will 'draw' out in fine threads in this way; and the length and fineness of the threads before fracture takes place are reliable indications of the degree of acidity in the curd. The longer and finer the threads the greater the acidity, but when a certain degree of acidity has been attained—usually about ·8 per cent or 1 per cent in the moisture present—the curd does not form threads at all, but simply melts on the iron. This hot-iron test is a comparative one only, and no definite standard of acidity can be laid down, but a careful and experienced person can, by its use, obtain very reliable results. See CHEDDAR CHEESEMAKING.

[w. s.]

Houdan Fowl.—About thirty years ago it was generally expected that the Houdan would become one of the most popular fowls for practical purposes, owing to the fact that it is probably the best of the non-sitters in its meat qualities, but that anticipation has not been realized, largely owing to the development of the crest. The birds have a somewhat large crest, which has been greatly developed, and in a moist climate such as we find in Britain this is a serious disadvantage, as the birds are liable to cold through the feathers becoming wet. The Houdan is of French descent and of mixed origin. It is generally supposed to have originated from a cross between the Crevecœur and the common five-toed fowl, as it has the characteristics of both these breeds. It is a large square-bodied fowl, carrying the breast well forward, with short neck and legs. The head is surmounted by a crest, and there are large muffs and a beard. The comb is peculiar, and is very pronounced in the male bird. The flesh is white, the legs are pinkish-white, and it has five toes,



Houdan Fowl

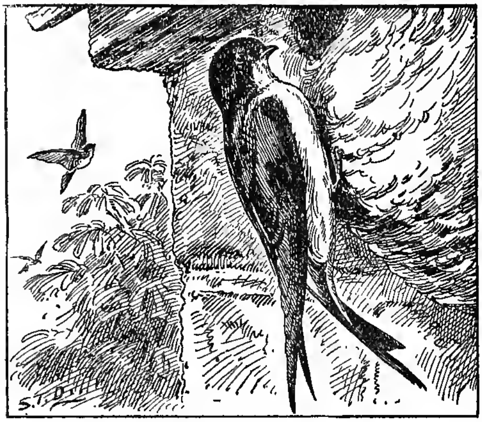
thus showing its descent from the Dorking. It has 'splashed' or black-and-white plumage, some of the feathers being white and some black. The markings are quite definite, and the colour is not grey, which would be the case if intermixed.

For practical purposes the Houdan is a very valuable fowl indeed. It is a good layer of large white-shelled eggs, and upon kindly soils and in a dry climate it is a breed that can be thoroughly recommended. Though it does not compare favourably with the special breeds of table fowls, yet the chickens grow rapidly and the flesh is very good in quality, meeting market requirements so far as colour of flesh and skin is concerned. It has light bone, and, as is always the case with birds having five toes, the table properties are specially prominent. For crossing purposes this breed is a very useful one, and some of the best layers we have seen have been crosses between the Leghorn and Houdan. Although it does not fill out in flesh to the same extent as some other breeds, yet when fed off it makes meaty and fine-flavoured chickens. As the birds are very quiet in disposition they are easily fattened. In this breed the French type

is distinctly better than the English for practical purposes, in that the development of crest has not been carried to the same extreme. [E. B.]

House Ant, a small red ant which infests some of the houses in the south of England. See MONOMORIUM.

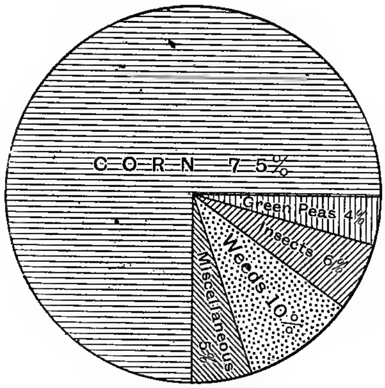
House Martin (*Hirundo* [*Chelidon*] *urbica*).—This social and familiar migrant is often



House Martin

mistaken for the Swallow (which see), but can readily be distinguished by its white under surface and rump. Most of the upper surface is steel-blue in colour. Besides this, the wings are shorter and the tail less markedly forked than in the swallow, while the feet and toes are feathered. The House Martin reaches this country about the end of April, rather later than the first swallows, and leaves in early October, though some individuals linger here as late as December. The rounded clay nest, with a small side entrance, is commonly constructed under eaves and in similar places. It is lined with dry grass and feathers. At least two broods are reared in the season, and birds return year after year to their old nests. The five eggs are pure-white in colour. The food consists entirely of insects, mostly gnats, crane flies, and other noxious two-winged forms. They are caught in the air for the most part, but are also to some extent collected from the ground. House martins are entirely beneficial, and deserve not only protection but encouragement. Their numbers are unfortunately decreasing, partly owing to their wanton slaughter in South Europe for culinary and millinery purposes, and partly because of the persecution to which they are exposed by that rapidly increasing pest the house sparrow. [J. R. A. D.]

House Sparrow (*Passer domesticus*).—The natural area of distribution of this constant companion of civilized man, aptly termed by Tegetmeier the 'avian rat', includes practically all the grain-growing regions of Europe. Introduced into Australia, New Zealand, and North America, it has increased with amazing rapidity and become a serious pest. Detailed description of so familiar a species is unnecessary, but we may note that the male is distinguished by his grey crown and black 'brooch', while both sexes possess a whitish patch on either side the head. Length, about 6 in. The nest is an untidy mass of miscellaneous material, lined with feathers, and when built in an exposed situation is roofed over, access being afforded by a side entrance. The nests are to be found in the most varied places, nearly always near human dwellings, but at most a mile away. Swallows and house martins are often deprived of their legitimate homes by this quarrelsome and impudent bird. The four to seven eggs are pale-bluish-white in colour, spotted and blotched with brown and lilac. The neat cup-shaped nest and self-coloured blue eggs of the useful hedge sparrow (which see) cannot be confused with those of the 'spadger', and should on no account be destroyed. As two or three broods are reared during the summer, and the bird is very hardy, being indifferent to extreme temperatures, the rapid increase and diffusion of the species are readily intelligible. Originally no doubt a feeder on wild grains and seeds, with a small proportion of insect food, the sparrow has linked his fortunes with those of man, and unfortunately turned his attention to cereals and other cultivated plants. J. H. Gurney and Col. Russell, after examining the crop contents of numerous specimens, give the percentage amount of different kinds of food as follows: Corn, 75; green peas, 4; insects, 6; weeds, 10; miscellaneous, 5. The accompanying diagram shows the meaning



Sparrow Food

of these results at a glance. Sixteen per cent of good is not much to set against 79 per cent of harm. Most damage is done to cereals during the final stages in ripening of the crop, when thousands of sparrows live in the fields and may render a profitable harvest impossible. Later on they pilfer grain from barns, ricks, and the poultry yard. To the gardener they are also a nuisance, stripping the buds from gooseberry and currant bushes, devouring young carnation shoots, destroying the seeds and seedlings of peas, and wantonly tearing bright flowers to pieces (primrose, crocus, violet, &c.). On the other hand, sparrows destroy a certain number of insect pests, upon which their nestlings are

partly fed (up to 50 or 60 per cent of total food), though much grain in the 'milky' stage is also taken for their benefit. About forty years ago they subdued a plague of cockchafers in Ireland, and some time since were reintroduced into Hungary at considerable expense. The harm, however, far outweighs the good, and we must not forget damaged ricks and thatch, gutters and pipes blocked by nests, the foliage of ornamental shrubs defiled or destroyed by the birds' corrosive excrement, and the way in which purely beneficial forms (*e.g.* swallow and house martin) are interfered with or driven away. Absolute extermination of any native species is a dangerous procedure liable to be followed by disastrous and unforeseen consequences, nor is it recommended here. But the numbers of the sparrow must be reduced to reasonable limits, a very difficult matter, and only practicable by concerted action throughout the whole country. Care must also be taken that this does not result in the indiscriminate slaughter of small birds in general. Children in rural schools should be taught how to recognize the farmer's friends and foes. Nests, eggs, and nestlings are easily destroyed, and the adult can be trapped in various ways (see BIRD CATCHING), but poison is not to be recommended. Sparrow pie, by the way, is no despicable dish. The formation of local sparrow and rat clubs is another useful measure, and model regulations can be obtained gratis and post free from the Secretary, Board of Agriculture, Whitehall (Leaflet No. 84). Letters of application need not be stamped. Prof. Theobald says that one such club in a Kent village accounted for 10,000 sparrows in two years, apparently without effecting any diminution in the species. The conclusion is obvious.

[J. R. A. D.]

Hoven, a malady in cattle characterized by a distension of the rumen or paunch. See BLOWN; also TYMPANITIS.

Hover Flies.—These are small, often brilliantly coloured dipterous insects whose larvæ feed on aphides. They are also called 'breeze flies'. See SYRPHIDÆ and CATABOMA.

Humanized Milk.—The term 'humanized' has been applied to the milk of the cow after it has been so far altered as to render it more or less similar in composition to that of the average nursing mother; in other words, it is the *modified* milk of the cow. Cow's milk differs in composition from woman's milk, as the following table shows:—

AVERAGE COMPOSITION PER HUNDRED PARTS

Cow.		Woman.	
Water	87·0	Water	87·0
Total solids (fatty and non-fatty)	13·0	Total solids	13·2
The solids consist of—		The solids consist of—	
Proteids	4·0	Proteids (lactalbumin preponderates) ...	2·0
Caseinogen = 2·6			
Serum or lactalbumin = 1·4			
Fats	3·70	Fats	4·0
Milk sugar or lactose ...	4·48	Lactose	7·0
Ash	0·76	Ash	0·2

The differences consist, therefore, mainly of the following, viz.: Cow's milk contains double the proteids, a little less fat, and less milk sugar than does woman's milk. Under average circumstances, cow's milk has become somewhat acid before it is obtained for home use in cities, during which time, also, there is enormous multiplication of microbes. Mother's milk, on the other hand, is alkaline in reaction and microbe-free. The steps adopted to humanize or modify cow's milk for infant use are—(1) dilution with water, (2) neutralization with lime water, (3) addition of milk sugar or cane sugar, (4) addition of cream, and (5) pasteurization at 140° F.–160° F., or sterilization at 212° F.–215·6° F. Various mixtures have been used as humanized milk. One, for example, has the following composition:—

Cream (20 per cent)	10 parts	= 1 oz.
Cow's milk	30 ,,	= 3 ,,
Water	30 ,,	= 3 ,,
Lime water	10 ,,	= 1 ,,
Milk sugar	4 ,,	= 3 dr.

Humanizing of milk has been largely undertaken by municipalities for the feeding of the infants of the poorer classes. Modified milk is prepared in graded mixtures for infants of different ages, such as the following:—

Mixture 1 {Milk = 1 part. Water = 2 parts.}

Mixture 2 {Milk = 1 part. Water = 1 part.}

Mixture 3 {Milk = 2 parts. Water = 1 part.}

To each gallon of 1, 6 oz. of cream and 6 oz. of milk sugar; of 2, 4 oz. of each of these; and of 3, 2 oz. of each, are respectively added, along with, in some cases, a minute addition of salt. All the mixtures are sterilized at 212° F. for five to ten minutes through the medium of water or steam. In Copenhagen, mixtures such as the foregoing are made, and after being put in hermetically sealed bottles, are pasteurized at 185° F. for half an hour. The Aylesbury Dairy Company prepare a milk from equal quantities of good cow's milk and a 10-per-cent solution of milk sugar, the mixture being passed through a separator (the cream milk being used), then rendered faintly alkaline, finally pasteurized at

160° F. and kept in air-tight bottles, which has this composition, viz.—

Total solids	= 13·11 per cent.	
Proteids	= 1·82 per cent.	
Fat	= 4·02	,,
Milk sugar	= 6·88	,,
Ash	= 0·39	,,

Such a product approximates closely to the milk of the nursing mother; even in this, however, the curd produced by acid is not so fine as that of woman's milk, due to the fact that of the contained proteids the caseinogen is about double the amount of the serum or lactalbumin, whereas in woman's milk the proportion is reversed. Humanized or *modified* milk —as we prefer to call it—cannot be held to be anything more than a fair substitute for the milk of the mother when that supply is not available for the infant. [J. GI.]

Humble Bee. See BEES.

Humble Bee Wax-moth. See APHOMIA.

Humic Acid, Humin, Humates. See HUMUS.

Humlies, a name formerly applied to the cattle of Buchan, from which the present-day Aberdeen-Angus Cattle are in part descended. See ABERDEEN-ANGUS CATTLE.

Hummel.—Hummelling is the operation of detaching the awns from the grains of barley and bere. More or less of the awn of the grain is broken off during the process of threshing. But even after passing through the ordeal of the beaters or teeth of the drum and the other disruptive contrivances peculiar to the threshing mill, too much remains attached to the grain to make it fit for presentation at market. A hummeller is attached to all threshing mills that are likely to have either barley or bere to dispose of. The usual form of apparatus for this purpose which accompanies the country mill is an erect cylinder with a certain number of cross bars of a lightish section fixed across the same at a regular distance apart. On a shaft that works in the centre of this cylinder are fixed another series of similar bars or blades, set so as to work between those that are fixed to the cylinder itself. The cylinder is filled with barley, and the movable arms being set agoing, the grains as they come under the influence of the arms—both fixed and moving—get shorn of their awns and drop out of the cylinder docked and ready for market. The more effective this operation of hummelling the trimmer-looking is each grain, and the more presentable is the sample of barley to the eye. But it can easily be overdone. In shaving the awn end too closely we are liable to do the same with the other end where the germ lies, and in this way reduce the reproductive powers of the seed. It is not infrequent to subject oats to the hummeller in order to improve the plumpness and the specific gravity of the sample—to make it better-looking and at same time weigh more per bushel. But oats intended for seed should be saved from this. [R. H.]

Humulus, the hop plant. See HOP.

Humus.—The organic matter in the soil may be classified roughly as follows: (1) Undecomposed plant and animal matter; (2) partially decomposed and still decomposing organic matter, called humus; (3) simple organic substances, soluble in water. In the case of sedimentary rocks (by far the commonest in the United Kingdom) another and quite distinct class must be added—(4) the organic matter originally deposited with the soil.

Group 1.—This consists almost entirely of pieces of root, stems, and other residues from previous crops which have not yet had time to decompose. Even when the fragments are very small they may still be recognized under the microscope by the fact that they possess a definite cell structure. The chemical composition naturally varies with the crop and the conditions under which it was grown; in general the main characteristic is that there is a large amount of carbon relative to the nitrogen, so that the ratio $\frac{\text{carbon}}{\text{nitrogen}}$ is high. This group shows no special physical properties, and does not necessarily contribute to the fertility of the soil. It is advantageous on clays, because it opens them up and promotes aeration and drainage; but this effect is a disadvantage on lighter soils, since it causes them to dry out too much; indeed in extreme cases it may be justifiable to collect and burn the undecomposed material. As a rule, however, this material must be looked upon as useful, because it constitutes the reserve out of which more humus is to be made.

Group 2.—When roots, stems, leaves, &c., decompose, they lose all sign of cell structure and are converted into brown or black amorphous bodies. Three types of decomposition are recognized: (1) that taking place in presence of air and of sufficient calcium carbonate to prevent the soil becoming acid; (2) an intermediate type in soils where some, but not much, air gets in, and where there is little if any calcium carbonate, so that the soil may become acid; (3) an anaerobic decomposition, going on in absence of air. The first is seen in ordinary arable conditions, and gives rise to mould or 'mild humus'; the second takes place in pasture land, heaths, &c., and the product is called by the German writers, raw humus or acid mould; the third is seen in peat bogs and moors, where decomposition has gone on under water. These products are not to be regarded as definite substances, but rather as groups; whilst there are doubtless differences in chemical composition, they have so many properties in common that they may be conveniently studied together. It is, however, difficult in practice to draw the line between the minute fragments of roots, &c., which are just being decomposed, and the substances in this group. English and German writers call the whole of this group 'humus'; French and American writers, on the other hand, restrict the word 'humus' to a certain part of the group which, as will be shown below, is soluble in alkalis and reprecipitated by acids. This difference of nomenclature is very unfortunate, and must be borne in mind in studying the work of foreign writers.

Group 3.—Numerous scattered observations are on record indicating the presence of a variety of soluble organic substances in the soil,

but no systematic work has yet been done on the subject. Bulletin No. 47 of the United States Bureau of Soils (1907) gives a list of the compounds alleged to have been found in soils, to which the reader is referred for further information. It is not yet clear what effect these bodies have on the fertility of the soil.

Group 4.—When our sedimentary soils were formed they contained a certain amount of organic matter, some of which still remains. Miller in the Quart. Journ. Geol. Soc. 1903, vol. lix, p. 133, gives the percentages of carbon and of nitrogen present in some deep soils. Some of his results are as follows:—

		Carbon per cent.	Nitrogen per cent.	Ratio $\frac{C}{N}$.
Surface.	Clay with flints, Rothamsted	1·076	·115	9·4
Near surface.	Clay with flints, Rothamsted, 7 ft. 6 in. down ...	0·188	·0375	5·0
	Lower Bagshot Sand, Weybridge, 18–20 ft. down ...	0·02	·0038	5·4
	Gault Clay, Nackholt, 18 ft. down	0·427	·0415	10·3
At great depths.	Lower Lias, Mickleton, 700 ft. down	1·12	·080	13·9
	Purbeck Beds, Penshurst, 1074 ft. down	0·470	·021	22·4
	Oxford Clay, Brabourne, 1370 ft. down	0·786	·053	14·8

The organic matter at the lower depths cannot have worked down from the surface, but must have been deposited with the soil. The amounts are about one-tenths to one-fifth of the quantities ordinarily found in arable clays, and it therefore appears that 10 or 20 per cent of the organic matter present in arable soils may be as old as the soil itself. Such organic matter is not likely to be of much use in the soil, but it is not entirely useless, for it will slowly nitrify under favourable conditions.

In the rest of this article we deal only with group 2.

Humification.—It has already been stated that there are three types of decomposition whereby plant residues are converted into humus or 'humified', resulting in the formation of 'mould', 'raw humus', and 'acid humus' respectively. *Mould or mild humus* forms in arable and garden soils when sufficient air, moisture, and calcium carbonate are present, and so long as the temperature conditions are favourable. The actual agents in its production appear to be bacteria and moulds, chiefly the former; but as these organisms cannot move about in the soil to any extent, it is necessary that the organic matter should be widely distributed. Earthworms play a great part here: they draw leaves, stems, &c., into their burrows, and pass quantities of plant residues and soil through their bodies, whereby an intimate mixture is obtained, and the micro-organisms are brought into close contact with the plant material. A certain amount of change also takes place in the body of the earthworm.

The chemical changes have been but little investigated, but it is known that quantities of carbon dioxide are given off during the process, and that there is considerable loss of material. The loss falls mainly on the oxygen, to a smaller extent on the carbon, and to a still smaller extent on the nitrogen, so that the ratio $\frac{\text{carbon}}{\text{nitrogen}}$ decreases; instead of 43 or 23, the ratios obtaining in cereal and leguminous stubbles respectively, the value is now reduced to 10.

Raw humus arises wherever the conditions are somewhat acid and sufficiently aerobic, and where, consequently, moulds act more freely than bacteria; instances are found in pastures, heaths, forest soils, the 'steppes' of Russia and Asia, &c. Various moulds are found on the humus, and are supposed to have played an important part in its production, among others *Cladosporium humifaciens*, *Trichoderma viride*, and *Cephalosporium Koningi*.[1] It does not, however, appear that moulds can complete the process; on the acid grass plots at Rothamsted, where moulds are active, but bacteria are probably kept in check, the process of humification is incomplete.

Little is known about the chemical changes involved, but there is a loss of substance, as in the formation of 'mould', and the losses are in the same direction, *i.e.* they fall most heavily on the oxygen, less on the carbon, and least on the nitrogen.

No clear chemical distinction is recognized between 'mild humus' and 'raw humus'. It is sometimes asserted that 'raw humus' consists of the free humic acid, and 'mild humus' is the calcium salt thereof. Such a simple view is probably not correct, and it is best to suppose that the substances are really distinct.

Acid Humus (*Peat*).—Moulds cease to act when air is excluded, as in water-logged soils, and decomposition is then brought about by anaerobic bacteria, and is virtually a putrefactive change. Marsh gas is given off in quantity —indeed this gas obtained its name from the fact that it is continuously being evolved from stagnant ponds and marshes—and an acid body, peat, is left. As in the previous cases, there is a steady loss of oxygen and a smaller loss of carbon, so that the peat is richer in carbon and nitrogen than the original vegetation, and it goes on getting richer as it ages. The following analyses by Detmer of peat from Jessbeck, in Schleswig-Holstein, illustrate this point:—

	Brown Surface Layer of Turf.	Peat 7 ft. below.	Peat 14 ft. below.
Carbon ...	57·75	62·02	64·07
Nitrogen ...	0·81	2·10	4·05
Hydrogen ...	5·43	5·21	5·01
Oxygen ...	36·02	30·67	26·87

[1] Lafar, Tech. Mykologie, Bd. 3, p. 451.

Whether the change that is still going on at the lower depths is chemical or bacterial is not clear; it is certainly very slow (see art. PEAT).

PROPERTIES OF HUMUS.—*Chemical Properties.* —The first important chemical investigation of humus was made by G. J. Mulder at Utrecht. He examined the brown substance obtained by heating sugar with acids, and found that part was soluble and part was insoluble in alkalis: the former he called *ulmic acid*, and the latter *ulmin*. When the decomposition was continued for a longer time, or stronger acids were used, black bodies were produced, which, however, behaved towards potash like the brown ones, and were called *humic acid* and *humin* respectively. He then assumed that sugar, cellulose, and other plant substances would decompose in the soil in the same way, and give rise first to ulmic acid and ulmin, and afterwards to humic acid and humin, and he isolated from the soil a brown substance soluble in alkalis, which resembled the humic acid from sugar. At a still later stage in the decomposition he supposed that another acid was produced which had already been discovered by Berzelius and called *apocrenic acid*;[1] this was rather more soluble in water than the others, and accounted for the acidity of moorland water. This scheme was commonly accepted, and may even now be found in agricultural textbooks. The experimental evidence is, however, very slight. There is no proof of the fundamental assumption that plant substances decompose in the soil in the same way as sugar breaks down under the action of acids. Neither humin nor ulmin was extracted from the soil, nor was it ever shown that they exist in the soil. The 'humic' acid extracted by alkalis from the soil is very different in composition from the artificial product, indeed one resembles the other only in so far as both are black, colloidal, and acidic. Mulder's analytical results were:—

	'Humic Acid' from Sugar.		'Humic Acid' from—			
	1st sample.	2nd sample.[2]	Arable Land.	Garden.	Pasture Land.	Peat.
Carbon ...	64·4	63·4	56·3	56·8	56·1	59·0
Hydrogen ...	4·3	4·3	4·4	4·9	5·3	4·7
Oxygen ...	31·3	32·3	36·0	34·8	32·5	3·6
Nitrogen ...	—	—	3·3	3·5	6·1	32·7

Mulder supposed that the nitrogen was present as impurity, and was not an essential constituent of humic acid.

Later investigators have confined themselves to a study of Mulder's acid, and have not concerned themselves with the other constituents of humus. The names 'humin' and 'ulmin' are therefore best dropped.

HUMIC ACID (also called *humus* by French and American writers, *soluble humus, active humus, matière noire*).—Mulder's method of extraction by treating the soil with sodium carbonate was soon displaced by another, in which the soil is first treated with hydrochloric acid to liberate the 'humic' acid from its salts, then washed with water to remove chlorides and excess of hydrochloric acid, and finally extracted with ammonia or caustic soda. The 'humic' acid was precipitated from this extract by hydrochloric acid as a flocculent precipitate drying to hard, shiny flakes. Grandeau made a number of analyses, and gave the non-committal name '*matière noire*' in place of 'humic acid'. He found that it invariably contained nitrogen, phosphoric acid, potash, and other minerals, but not in any constant proportion; samples prepared from fertile soils were richer than others obtained from infertile soils. He considered that it played a highly important part in determining the productiveness of the soil. Hilgard in America took a similar view, and made a careful study of the amount of nitrogen present in different samples. The variations were considerable, but were quite regular; where the soil conditions were favourable to decomposition the nitrogen content of the humic acid was high. His results may be summarized thus:—

	Percentage of Humic Acid in the Soil.	Percentsge of Nitrogen in the Humic Acid.
Soils of the arid regions (decomposition rapid) ...	0·20 to 3·0	8·7 to 22·0 (average 15·2)
„ sub-irrigated arid regions	0·36 „ 2·0	5·4 „ 10·8 („ 8·4)
„ humid regions (decomposition slow) ...	1·0 „ 10·0	1·7 „ 7·0 („ 4·2)

In like manner the 'humic' acid of the surface soil was richer in nitrogen than that extracted from the subsoil; 5·3 per cent of nitrogen was present in a sample taken from the surface, and 3·76 and 1·54 per cent in samples taken 4 and 8 ft. respectively below the surface. Cameron and Breazeale[3] determined the amount of carbon in nineteen samples of 'humic' acid in American soils, and obtained results ranging from 33·3 to 50·1 per cent, and averaging 42 per cent. The average of the German analyses is 56 per cent.

[1] Called 'Quellsatzsäure' by many German writers.

[2] The figures agree closely with some obtained later by Berthelot and André, Comptes Rendus, 1897, vol. cxii, p. 916.

[3] Journ. Amer. Chem. Soc. 1904, vol. xxvi, p. 29.

It is therefore quite clear that the 'humic' acid obtained from different soils is not a definite chemical substance, but a mixture of bodies the composition of which depends on circumstances and on the method of extraction. This being so, it is impossible to give an average composition, and superfluous to quote lists of analyses; but as Mulder's figures for Dutch samples have been already given, we will set out Snyder's analyses of American samples:—

	Rich Prairie Soil.	Cultivated Soil.	Soil never Cultivated.	Soil Cultivated for Forty Years.
Carbon	45·12	48·16	44·12	50·10
Hydrogen	3·67	5·40	6·00	4·80
Oxygen	28·60	33·16	35·16	33·66
Nitrogen	10·37	9·12	8·12	6·54
Ash	12·24	4·16	6·60	4·90

We have stated above that Mulder regarded the nitrogen as an impurity, supposing pure 'humic' acid to be composed of carbon, hydrogen, and oxygen only, and the natural body to be an ammonium salt. The generally accepted view now is that the nitrogen is in protein-like combination, and this view is strengthened by Suzuki's experiments, in which typical products of protein hydrolysis were obtained by boiling 'humic' acid with sulphuric acid.

Decomposition of Humus in the Soil.—Little is known with certainty on this subject, but the following is a summary of the views generally held now. Humus is continuously being decomposed to form carbon dioxide, ammonia, water, and other bodies. The decomposition is doubtless brought about by micro-organisms, but has not yet been studied from this point of view. It is favoured by a suitably high temperature and by calcium carbonate; moisture and mineral food are likewise essential. Hilgard's results quoted above show that nitrogen tends to accumulate in the residual soluble humus during decomposition, *i.e.* that carbon and oxygen are lost more rapidly than nitrogen. The effect of calcium carbonate is well illustrated in an experiment made by Wheeler, Sargent, and Hartwell at the Rhode Island Experiment Station. Soils variously manured, with and without lime, were put up in pots and cropped for three years. At the end of the time the soluble humus was extracted and analysed. The lime had facilitated decomposition, and so caused a fall in the amount of soluble humus, but the percentage of nitrogen contained therein increased:—

	Percentage of Soluble Humus.		Percentage of Nitrogen in the Soluble Humus.	
	Unlimed Soil.	Limed Soil.	Unlimed Soil.	Limed Soil.
No nitrogenous manure	3·86	3·51	3·37	3·68
Manured with sulphate of ammonia	3·98	3·77	3·26	3·47
Manured with nitrate of soda	3·93	3·42	3·64	3·89

It has not yet been shown whether humus rich in nitrogen decomposes more slowly or less slowly than humus poor in nitrogen. Hilgard considers that humus containing about 4 per cent of nitrogen is most useful as a source of plant food. The rate at which soluble humus is lost from the soil by decomposition has not been much investigated. Snyder at Minnesota found that 1 ton per acre was lost each year under conditions of continuous wheat cropping, but very much less when clover was alternated with wheat. Much more investigation of the important problems connected with the decomposition of humus is wanted.

The Humates.—Humus readily absorbs the free alkalis, potash, soda, and ammonia, from their solutions, forming bodies insoluble in water but soluble in excess of alkali. These are called humates. Calcium humate can be obtained by treating humic acid with lime or calcium carbonate;[1] it is quite insoluble in water. Advantage is taken of this fact to remove from moorland waters the soluble humic acid, which, by dissolving lead, renders such waters unfit for town supplies. The water is filtered through calcium carbonate to precipitate the acid body; a certain amount of calcium carbonate goes into solution; and the water now no longer corrodes lead pipes, and is perfectly safe for domestic use. Calcium humate plays an important part in the soil. It is supposed to be the form in which soluble humus actually occurs. It decomposes more rapidly than humus itself, forming calcium carbonate in addition to ammonia, carbon dioxide, mineral matter, &c. It is thus a source of calcium carbonate in the soil, and is an important source in certain moorland soils (see Chemical Society's Annual Reports, 1904, p. 207), and in soils rich in organic matter. It is possible that these so-called humates are not true chemical compounds, but simply physical combinations.

Berthelot has studied the 'humates' obtained by treating artificial humic acid (from sugar) with compounds of potassium, sodium, &c.

[1] Schloesing's method is to add hydrochloric acid to the ammoniacal solution till a precipitate begins to form, and then add excess of calcium chloride.

Physical Properties.—The physical properties of all the varieties of humus can be summed up in the statement that they are black colloids. The word 'colloid' was introduced by Graham and means 'like glue'. Colloids readily absorb water and swell up, but they do not actually dissolve in water, and are therefore not diffusible. They also absorb certain compounds, to which they stick with great tenacity. From this point of view the properties of humus have been very completely studied by van Bemmelen, and published in Landw. Versuchs-Stat. 1888, vol. xxxv, p. 69. (The view that absorption is physical is also strengthened by van Schermbeck's experiments in Jour. Prak. Chemie, 1907, vol. lxxv, p. 517.) He regarded the absorption of alkalis and ammonia as physical, and not chemical. When, however, humus is brought into contact with a salt solution there is an interchange of bases, some of the bases of the humus (for, as has already been pointed out, humus is never free from mineral matter) replace some of the bases of the solution. Thus when humus is treated with a solution of potassium chloride, potash is absorbed, but lime and magnesia go into solution. In this case there is no change in the concentration of the acid ion, and the amount of chlorine in the solution is unaltered. A similar interchange takes place when potassium phosphate is used, but here the calcium and magnesium phosphates, being insoluble, are precipitated, and there is therefore a withdrawal both of base and of acid from the solution. If the sample of humus contains little or no lime and magnesia, then phosphoric acid is not withdrawn from solution. This absorptive power is reduced to a minimum by extracting the humus with acids to remove the mineral matter as far as possible, but it never entirely disappears; there is indeed some evidence that humus can absorb small quantities of salts as a whole.

Its power of absorbing water is very considerable. It increases to twice and sometimes even to eight times its original volume when wetted. Where there are large masses of humus, as in peat bogs, the swelling after prolonged heavy rainfall may be considerable, and may even lead to dangerous results. Peat bogs in Ireland situated on the hills have overflown into the valleys with disastrous consequences, while the overflows that used to occur on the Lancashire moors, *e.g.* on Pendle Hill, have been graphically described by Harrison Ainsworth. The proper remedy is drainage, which prevents water accumulating in the peat. Conversely, humus shrinks on drying. This, again, is illustrated by peat bogs and moors, which on draining begin to shrink, and undergo a slow but steady erosion as air penetrates into the newly formed spaces and starts the oxidation processes working.

The cementing action of humus is of importance in two ways: it binds together the coarse particles of light soils, making them more coherent; it cements some of the finest clay particles of heavy soils, making them into coarser particles, and so renders the soil as a whole more easily workable. It is, however, only a weak cement, and is not markedly adhesive or plastic like clay.

The black colour of humus increases the amount of heat absorbed from the sun's rays, thus causing the soil to be more easily warmed.

Humus is the lightest of all soil constituents, and its true density, when the particles are all separated, is 1·4. Its apparent density, as determined when the particles are packed together in the natural condition, is very much less, but is greatly influenced by the amount of water present. Wollny's figures are:—

	True Density. (Particles all separated.)	Apparent Density. (Particles packed as in nature.)		
		Air Dry.	Saturated with Water.	Increase due to Wetting.
Humus	1·2 to 1·5	0·3565	1·1024	209
Clay	2·50	1·0395	1·6268	56
Quartz sand	2·62	1·4508	1·8270	26

Effect of Humus on Fertility.—One of the oldest writers on agricultural chemistry, Wallerius (see Agriculturae Fundamenta Chemica, Upsala, 1761) ascribes four functions to humus: (1) It supplies food to the plant; (2) it attracts nourishment from the air and retains it for the plant; (3) owing to its porosity and solubility it allows air to penetrate to the germinating seed and to the roots of plants; without air, roots cannot grow; (4) it facilitates cultivation. He goes into some detail as to the way in which humus feeds the plant. Nourishment, he says, is only afforded by things of similar nature to the plant; mineral substances are of no use, and only substances occurring in or derived from those in plants act as foodstuffs. A food can only enter the plant when it is dissolved in water, and the 'essence' of humus is not readily soluble. Addition of salts, however, facilitates solution, and thus it happens that salts, which are not themselves of any value as plant food, may increase fertility by facilitating solution of the humus. This view, that humus is the proper food of plants, was developed by de Saussure: water forms the bulk of the plant and comes from the rain, carbon comes from the carbonic acid of the atmosphere, but nitrogen and the earthy matters come from humus or from animal and plant materials in the air. Davy took a very similar view, and up till 1840 humus was considered an essential plant food. In that year Liebig's celebrated Organic Chemistry in its Relation to Vegetable Physiology and Agriculture was presented to the British Association, in which humus was banished from the list of plant foods, though it was still re-

cognized as playing an important mechanical part in the soil. In one way it acts as a nutrient: by its decay in the soil it gives rise to carbonic acid, which forms the chief means of nourishing the plant roots; carbonic acid can, however, also be derived from the atmosphere. Some of Liebig's followers went even further, and maintained that addition of humus to the soil by dressings of dung was quite superfluous. Thus Georges Ville declared that 'la production du fumier a perdu sans retour le caractère de necessité imposée à la culture ... il est possible de composer artificiellement des engrais supérieurs au fumier et plus économiques'. He allowed that humus is useful by retaining water and ammonia, and furnishing a continuous supply of carbonic acid to dissolve the minerals in the soil, and especially calcium carbonate and phosphate.

Numerous experiments both in the field and the laboratory have shown conclusively that plants can grow quite well without any supply of humus, and it is definitely proved that humus is not an *essential* plant food, *i.e.* plants *can do without it.* But the great value of humus in the soil has caused the belief to persist that humus directly helps in plant nutrition. Grandeau (see Recherches sur le Rôle des Matières Organiques du Sol dans les phénomènes de la nutrition des Végétaux, 1872; also Comptes Rendus, vol. lxxiv, p. 988), whose researches have already been mentioned, considered that *matière noire*, though not itself a plant food, acts as the vehicle whereby plants get their food in ordinary soils. The mineral plant foods (phosphoric acid, potash, lime, silica, &c.) invariably found in *matière noire* can be dialysed out, and are thus extracted by the plant roots, and the only part of the mineral matter of the soil useful to vegetation is that contained in the *matière noire.* This view was supported by a large number of analyses, of which the following table is a summary:—

	Total Organic Matter.	Total Phosphoric Acid.		*Matière noire.*	Phosphoric Acid in *Matière noire.*	
	per cent.	per cent.	Kg. per Ha.	per cent.	per cent.	Kg. per Ha.
Rich agricultural soils, fertile without manure	6·79	·18	3719	2·09	10·1	2641
Forest soils, fertile without manure	6·71	·41	2212	1·41	2·82	470
Agricultural soils, productive only when manured ...	5·68	·17	7964	0·76	2·33	448

(1 kilogram per hectare = 1·8 lb. per acre; 1000 kilogrammes per hectare = 16 cwt. per acre.)

Although Grandeau's view is not now accepted, it is still held in France that the soluble organic bodies derived from humus are taken up by plants and constitute valuable food materials (see Déhérain, Chimie agricole; also Dumont, who has made a special humic manure, Comptes Rendus, 1905, vol. cxl, p. 256). The evidence is not very convincing, but there is nothing against this view; it has never been shown that plants get the whole of their carbon from the carbonic acid of the air and none from the organic matter of the soil.

Hilgard, like the French writers, attaches great importance to *matière noire* in plant nutrition, but for quite another reason. He supposes that it constitutes the main source from which nitrates are formed in the soil; it is readily nitrifiable, whilst the rest of the organic matter is not. The total amount of nitrogen in *matière noire* combination therefore represents the amount available, or likely to become available, to the plant.

In the light of our present knowledge we may say that humus is useful in the soil in two ways:—

1. It is steadily decomposing with formation of (*a*) ammonia, which is further changed to valuable nitrates; (*b*) carbonic acid, which aids in the solution of mineral matter, *e.g.* of phosphates, potash compounds, &c.; (*c*) mineral matter which is in a form easily available to plants; (*d*) other substances which may be useful plant food.

2. It imparts some of its physical properties to the soil, and thus (*a*) helps to retain ammonia and soluble salts, which would otherwise wash out; (*b*) acts as a weak cementing agent, and improves the texture both of light and of heavy soils; (*c*) for both these reasons it improves the water-holding power of the soil, and reduces percolation and drainage; (*d*) being black it causes the soil to warm more readily.

The value of humus in improving the mechanical condition of the soil and in tilth production is well seen on the Rothamsted Barnfield plots, where root crops (which naturally do not leave much residue, unlike cereals) have been grown since 1843, and where, consequently, the tendency is for humus to diminish. Plots receiving dung can always be got to a satisfactory tilth; those receiving no organic manures cannot always. In practice the effect is seen best in certain subtropical countries where no steps are taken to replace the humus as it rapidly disappears under the action of micro-organisms, &c. In the southern parts of the United States, cotton, maize, &c., are grown, but the residues left are not sufficient to keep up the supply of humus; the soil then gets into a bad physical state. A similar exhaustion is likely to take place in tea plantations. The remedy is to add organic matter, either by organic manures or by green manuring.

The effect on the water content is shown in the following table, which gives the percentage of water present in some of the Rothamsted soils.[1]

[1] See King, The Soil, p. 290, for similar results obtained in America.

	Broad Balk Wheatfield.		Hoos Barley Field.	
	Unmanured Plot.	Dunged Plot.	Unmanured Plot.	Dunged Plot.
Top 9 inches	16·0	19·3	17·0	20·7
9–18 inches	19·8	17·0	22·5	17·7
18–27 inches	23·3	18·4	22·1	18·3

The determination was made after the harvest of 1904; there had been one day's rain shortly before the sample was taken. This was held near the surface on the dunged plot, and thus causes an increase in the percentage of water. It percolated through on the unmanured plot, and so tends to increase the water in the lower depths, which, however, is not so valuable to plants as water near the surface. That this is the usual course of events is shown by the fact that the drain pipes on the dunged plots only very rarely run, while those on the unmanured plot run much more frequently. Organic matter (humus in particular) is thus seen to retard the rate at which water is lost from the soil, and to give the crop a greater chance of utilizing showers of rain. Whether it leads to any permanent increase in the water content is less clear: moisture determinations made every week for one year at Grignon gave the following average results:—

Three plots rich in organic matter, 18·5 per cent.
Three plots poor ,, ,, 17·6 ,,

The amounts of drainage water showed correspondingly small differences, being 188·7 mm. in the first case, and 194·3 mm. in the second. This experiment wants repeating on other soils.

Determination of Humus. — The German method (in which 'humus' means all the organic matter) is to burn the soil, estimate the carbon dioxide produced, and multiply by ·471. The method assumes that the organic matter contains 58 per cent of carbon. Houston and M'Bride's method (in which 'humus' means '*matière noire*' or 'soluble humus') is to digest the soil with 1 per cent hydrochloric acid (to dissolve all calcium carbonate and decompose humates), throw on a filter, wash with hydrochloric acid and then with water till neutral. Then wash into a 500-c.c. cylinder with 4 per cent ammonia, close, leave for a definite time (usually thirty-six hours), with periodical shaking, or if a mechanical shaker is obtainable, shake up for about twenty-four hours. After allowing to settle, pipette off an aliquot part, evaporate, and weigh; this gives the weight of humus + ash. Ignite and weigh to get the ash, subtract from the previous weight, and the result is the amount of 'soluble humus' present.

In order to determine the nitrogen content a fresh portion of the solution is evaporated with magnesia to drive off ammonia, and the residue treated by Kjeldahl's method.

Various newer methods for determining humus have been suggested, based on the oxidizing action of hypochlorites and permanganates, but their practical value is not yet proved. No two methods give the same result. The German method gives figures 50 per cent or more higher than the American method, because it includes *all* the organic matter of the soil.

Amount of Humus in Soils.—(*a*) Total organic matter (German method): sandy soils about 2 per cent, loams about 3 to 4 per cent, clays 4 to 6 per cent.

(*b*) 'Soluble humus': sandy soils about 1 per cent, loams about 1 to 2 per cent, clays 1½ to 3 per cent. These figures are for arable surface soils; figures for subsoils would be less, and for pasture soils more. The humic nitrogen is generally about one-half the total nitrogen.

[E. J. R.]

Hungarian Forage Grass, Awnless Brome Grass (*Bromus inermis*). See Brome Grasses.

Hungary, Agriculture of. See European Agriculture.

Hunia or Fighting Sheep are a domestic breed, the rams of which are kept by native princes in India for fighting. The colour is usually white, sometimes diversified with brown, especially upon the feet and head. As in many tropical and subtropical breeds, the nose in the rams is markedly arched; and the horns in this sex are of large size, massive, and project on each side of the head with a strong spiral or corkscrew-like twist. The ears are small and semi-pendulous, and the fleece is woolly. The tail is naturally short, measuring only 4 in. or so in length, and reaching about halfway down towards the hocks. An example of this breed was brought by the Prince of Wales from Nepal in 1906; and it is a notable fact that its tail resembles in length that of representatives of two distinct breeds, namely the one-horned and four-horned races, brought at the same time from that country. The explanation of the prevalence of short tails in breeds from Nepal probably lies in the fact that the Nepalese are prohibited by a tenet of their religion from using as food sheep which, like the majority of domestic breeds, are naturally long-tailed. During a recent visit to England the Maharajah of Nepal and his suite were dependent for mutton upon short-tailed St. Kilda sheep. [R. L. P.]

Hunter, The. — The Hunter is probably the best specimen of the pleasure horse to be found in the world. He owes his origin to the ingenuity of our sporting tastes as Britons, and is a result of successive crosses of the finest Normandy blood with imported Arabs; he also exhibits evidences of descent from the smaller horse (really pony) indigenous to Great Britain and Ireland. Like all our 'light' horses, Hunters have been evolved from smaller-sized forefathers, and have increased in height through

care and attention in feeding and rearing; in the same way our racehorses have become bigger during the last hundred years.

A high-class Hunter should have the following characteristics: He should stand about 16 hands in height; if bigger, he runs the risk of becoming a roarer. He should have at least three direct crosses of thoroughbred blood on his dam's side. He should have good flat-boned legs and well-formed feet. His shoulders should be strong, deep, and sloping; his back strong and well knit into his loins; his hind quarters should be muscular and wide, with thighs well let down, and hocks clean, straight, and set on as low as possible; his tail set on square with his hips; his girth at the saddle should be at least 6 ft., with plenty of room in his chest and breast for heart and lungs. His head should be well set on to a moderately light neck, and the eye expressive of docility and courage. His whole contour should denote that symmetry of proportion which is so conducive to smooth action and moderate speed. He should be uniformly coloured as far as possible, with a small white star on his forehead. In a high-class Hunter, good behaviour and an obedient disposition are a great consideration, especially in these days of crowded hunting fields, and for this reason the early handling, mouthing, and training of a Hunter is very essential to his future worth and success. Moreover, he should not be called upon for supreme exertion in the hunting field until he is at least five or rising six years old. He should be handled at three years old; gently ridden, well mouthed, bridled, and hacked at four years; bustled up and pushed along over fences and rough ground, with a short hunting day at five years; becoming a finished Hunter at six years old. Thus a Hunter takes longer to come to perfection and into general use than any other horse, and his breeding and education are therefore most expensive. Hence it is that ordinary farmers and breeders have during the last fifty years found it more remunerative to breed Shire horses, Clydesdales, or Hackneys, and the supply of horses of the Hunter type, even in Ireland, has gradually decreased, until at the present time it has become a serious question as to how our military requirements in remounts are to be met, seeing that, according to recent returns published by the Board of Agriculture there was a falling off of 10,000 foals in light-horse breeding during the year 1907. At the present day the paltry sum of £5000 a year, which is distributed in premiums for thoroughbred sires suitable for breeding Hunters by the Royal Commission on Horse Breeding, and which is given to twenty-eight horses, distributed throughout England, Wales, and Scotland, is totally inadequate, and The Hunters' Improvement Society, which has been in existence since 1885, has laboured unceasingly in the cause of Hunter breeding, and has established a stud book for mares and Hunter-bred sires of a recognized standard; yet its work has been hampered through want of sufficient funds to provide more Hunter sires, and a better market for horses for military purposes at three years old.

Hunters are now chiefly bred in Ireland, where the demand exceeds the supply. It has been said that a good Hunter can go in any country, but our experience goes to prove that Hunters should be bred to suit the district in which they are to hunt. Thus in Leicestershire and Northamptonshire a three-parts-bred horse, with speed and aptitude to clear flying fences, ox rails, and brooks, is the only one of value; whereas in the more cramped districts of the Midlands, where the enclosures are smaller, you want a cleverer horse, that will spring off his hind legs at a slower pace, be able to go on and off banks, creep in awkward places, or jump big ditches from a stand. He does not require to be quite so big or high-priced as a Leicestershire Hunter. Again, in the big Vale of York you want a powerful half-bred horse, that can carry you across ploughed land and be able to negotiate stiff fences and wide ditches at a moderate pace without distressing himself. On the wolds of Yorkshire and the downs of Sussex, Hampshire, and Wiltshire you want a speedy horse of the thoroughbred type, possessed of good shoulders, sound wind, and able to gallop both up and down hill at the will of his rider, or according to the pace at which hounds may run.

In districts where walls abound, such as part of the Badminton, Heythrop, Cotswold, or V.W.H. hunting countries, a handy horse is wanted, that will rise quickly and throw himself over without the effort of a big jump. Although a wall stands up rather formidably against you as you approach it, yet, if you do not go too fast at it, a horse that understands walls seems to throw himself over with great ease. We know no pleasanter gallop than over walls on a steady jumper, with the hounds topping the next wall in front of you, and you are riding on light ploughland, which hinders you but little. There are a few walls in the North and in parts of Yorkshire.

Then again, if you wish to hunt in Devon, Cornwall, or Wales, where not only hills have to be climbed, but banks have to be got over, and gullies crossed, you require a clever little Hunter with a short stride, that can change his leg in jumping a bank, and has the ability to cross a rough country with safety. He must be well and stoutly bred, or he will be useless in such districts.

Hunters may be classed in their various capacities as follows: The big, weight-carrying, well-bred, and highly valuable Hunter; the light-weight Hunter of high breed and quality; the squire's Hunter, an animal more to be recommended for his soundness than his points and style, but nevertheless a Hunter in character and of moderate value; and the ladies' Hunter (for ladies nowadays take a not unimportant place in hunting fields). This latter horse should be nearly a pure thoroughbred—a nice flippant horse, with a good mouth and manners, capable of carrying 12 st. to hounds in any country. The demand for such horses is always active.

The hunt servants, especially the huntsmen, require good hardy, well-seasoned horses, which know their business. In fact, every M.F.H. of

Photo. W. A. Rouch.

FAMOUS HUNTER SIRE—"RED PRINCE II"

SEVERAL TIMES CHAMPION AT THE ROYAL DUBLIN SHOW

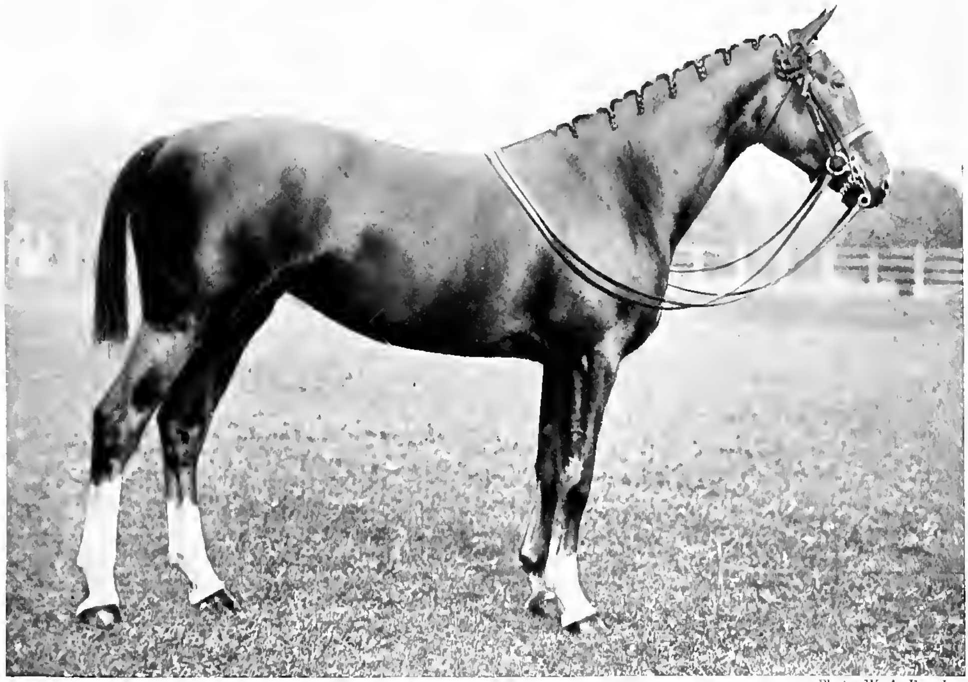


Photo. W. A. Rouch.

HUNTER FILLY—"PRINCESS ROYAL"

WINNER OF 1ST PRIZE AND GOLD MEDAL OF HUNTERS' IMPROVEMENT SOCIETY, R.A.S.E. SHOW, 1907.

repute, in buying his horses, thinks first of how he shall mount his huntsman, because much of the sport depends upon the ability of the latter to ride well up to his hounds. A huntsman's horse, therefore, must be bold, clever, and lasting. He has generally to go first over whatever jumps come in his way without hesitation, and he cannot be steadied or rested as other hunters are during a run. A good huntsman's horse is of much value, and rightly so.

Then there is a horse that must be classed among Hunters, although in breeding and conformation he is more of a racehorse or steeplechaser. This is the hunt racehorse, which, now that point-to-point races are so fashionable, finds his way into a great many hunt stables, and is brought out for light days during the season to qualify for the spring hunt steeplechases, in which our young sportsmen delight to take part. As a rule he is not a horse of any great value, in fact often a screw, but he must have the essentials of blood, speed, and some jumping ability. If he proves of merit he is soon promoted to the higher grades of steeplechasing; if the contrary, he generally degenerates into the cab rank.

There is yet one other class of Hunter which we must touch on, and that is the hack Hunter. Force of circumstances have probably brought him out of the rôle of a single-harness horse or polo pony. He becomes a boy's or girl's hunter, carries a man to covert, or perhaps is hired out by the day to casual sportsmen by the livery stable keeper. Useful, well-bred, and often clever horses are these hack Hunters, on which young sportsmen, with little care for their necks and eager to see most of the fun, can and do enjoy themselves occasionally. Perhaps we have to thank the Polo and Riding Pony Society for the breeding of most of these hacks. But hacks are more often the outcome of misfits in Hunter breeding.

In regard to the breeding of Hunters, we may say that we consider it essential to success that the sire should be either a thoroughbred horse with bone and power, or a three-parts thoroughbred horse, such as can be registered in the Hunter Stud Book as a recognized Hunter sire. The dam (that is, the mare you intend to breed from) should be free from hereditary diseases, of approved worth, and, if possible, possessing three direct thoroughbred crosses on her sire's side — such a mare, in fact, as is eligible for registration in the Hunter Stud Book. We come across instances of good Hunters that are cross-bred with the Hackney, the Shire, and the Clydesdale; yet this should be avoided, as we have known instances of disastrous failures from these experiments. The Hackney is too impetuous and hot-tempered, besides being not by any means a long-winded horse; and those bred from Shires and Clydesdales are slow and awkward when it comes to real galloping in a fast run. We have known some good Hunters with Arab blood in their veins. They are stanch and sound horses, although they have not the appearance of weight carriers. A cross with the pony two or three generations back is an appreciable advantage to a Hunter, as we can vouch for.

The beautiful specimens of Hunters to be seen now at our leading country shows are an object lesson of the ideal to which clever breeders of Hunters should hope to attain. The art of showing them with the perfection of condition and manners has been attained by few, and among these Mr. Stokes, of Market Harborough, is undoubtedly foremost, and he worthily carries off a majority of the numerous prizes given for Hunters throughout the country.

[R. D. G. P.]

Hunting.—Spoken and sung of in every known tongue, and from the most ancient of days, is the sport of hunting, which is varied in its pursuits through each bygone age. Right royal in its patronage, it has ever been foremost amongst national sports. To trace its history would entail a survey of the world's events since the primeval days of Noah, whose great-grandson Nimrod, we are told in the Book of Genesis, was 'a mighty hunter before the Lord', and so on through the days of the Patriarchs, when the population of the world was scant, and the beasts of the field had to be subdued. We know from the earliest sources of learning in Egypt, Assyria, and Greece, down to the days of Xenophon, that hunting was 'a noble art', and such it has remained ever since.

In England we have to thank our earliest dynasties for its rise and encouragement,—probably the Normans most of all, because they introduced not only better horses into the country, but also hounds suitable for the chase, and methods of the chase, which had been practised in the forests of northern France, and to which our native forests and heathlands were so suitable. Thus the sport of hunting grew amongst us on the most adaptable climate and soil practised alike by nobles, ecclesiastics, and laymen down to the 14th century, a record of which we have handed down to us in a treatise on hunting from the huntsman, William Twici by name, to King Edward II. This work, written in French, was translated into English by John Gyfford, and is considered the first standard work on hunting in this country. Next we find a noted prioress of St. Albans, Dame Juliana Berners, writing a treatise on hawking and hunting in 1486; and a book called The Maister of the Game was supposed to have been written by Edmund de Langley, Duke of York, son of Edward III, and has been much quoted by 'Cecil', a recent writer on hunting. We have also the writings of Turberville and Sir Thomas Cockayne in the 16th century to add to our early literature on hunting. We know from Chaucer's Canterbury Tales that bishops and high ecclesiastics delighted in hunting, and took full advantage of a charter of Henry III, giving them the special advantages of hunting in the royal forests when travelling through them. The Bishop of St. David's in those days kept a pack of hounds, for we find his friend Reginald Brian, Bishop of Worcester, writing to him for his promised gift of some of his hounds. 'Let them come,' he says, 'reverend father, without delay. Let my woods re-echo with the music of their cry, and the cheerful notes of the horn, and the walls of my palace be decorated with the trophies

of the chase.' So fond, indeed, did the clergy become of hunting in those days, that in the reign of Henry VI they were particularly warned against 'huntinge, hawkinge, and dawnsinge'. Nevertheless Queen Elizabeth was notably fond of hunting, as we have reliable records of her prowess at the grand entertainment given in her honour by Leicester in 1575; and even in her seventy-fourth year she is described as 'well and excellently disposed to hunting, for every second day she is on horseback, and continues the sport long', at her palace at Oatlands; and the Lady Salisbury of that day kept a pack of dwarf foxhounds at Hatfield, and dressed her hunt servants in sky-blue uniforms, black collars, lapels, and jockey caps, and we find these dresses depicted in old sporting pictures of that, and even later periods. It may be worthy of note that among the many ladies that have distinguished themselves in the sport of hunting was Miss Diana Draper, daughter of William Draper of Berwick Hall, in Yorkshire, who devoted a long life to 'cheering her father's hounds with her voice', and died, without any broken bones, in her bed at the age of seventy-five. Squire Draper kept a model hunting establishment, and his first toast was 'All the brushes in Christendom'. His income was only £700 a year!

That the Lord Mayor of London should ever have been a master of hounds and had meets at Lincoln's Inn Fields, St. James, and Mayfair seems to us improbable, yet 'Cecil' avows it, and has authority for doing so. And this hunt was called 'The Common Hunt'. Probably it was the forerunner of 'The Epping Hunt', as it was the scene of a turned-out stag hunt, and we find a relic of it in the well-known hostelry called 'The Baldfaced Stag', which was near the scene of the turnout, and where refreshment for the Cockney sportsmen was provided.

In 1733 appeared an anonymous work on hunting, which Beckford takes as his text in his 'Thoughts on Hunting'. In those days the hare was chiefly the object of the chase, as is clearly shown in Beckford's writings. Lord Barrymore, and after him Colonel Thornton, adhered to the Louis XIV style of uniforms, having four attendant hunt servants in scarlet and silver with French horns, blowing loud blasts, much to the astonishment of the Yorkshire woldsmen in the neighbourhood of Foxhunters' Hall. Then we have the noted hunting poet Somerville, whose verses ring with the true echo of the sport he loved. Our sporting writers of later days are chiefly Delme Radcliffe, 'Nimrod', 'The Druid', 'Scrutator', 'Cecil', Surtees, Vyner, John Mills, Tom Smith, Bromley Davenport, and Whyte-Melville, not forgetting the Cheshire poet, Egerton Warburton.

It was not until the middle of the 18th century (about 1750) that foxhounds came into general vogue as established packs. Lord Arundel had hounds hunting in Hampshire and Wiltshire, which were purchased by Mr. Meynell, and no doubt formed the nucleus of the first Melton pack, afterwards called the Quorn pack; and the record tells us that Thomas Boothby of Leicester kept foxhounds for fifty-five years, and died in 1752. The Badminton Hunt dates from 1762; the Belvoir from 1750; and the Old Berkeley Hunt, which extended from London through Middlesex, Buckinghamshire, Oxfordshire, and Berkshire, was established about this time; while the Tarporley (Cheshire) Hunt dates from 1762. Royalty still stuck to staghounds. Henry VIII had his royal kennels at Swinley, near Ascot, and King Charles First and Second enjoyed hunting when those troublous times permitted. Our present dynasty, commencing with the Georgian era, have retained the custom of keeping a royal pack in the vicinity of Windsor, and this only came to an end in the latter years of Queen Victoria.

Hunting the wild deer on Exmoor and throughout North Devon can be traced from 1598, and is still most popular and flourishing, thanks chiefly to Lord Fortescue and Sir Thomas Acland; and the Earl of Derby, the great-great-grandfather of the present earl, established staghounds at his seat, The Oaks, near Epsom, in Surrey. With the incoming of fox-hunting into the midland counties of England was introduced the fashion of hard riding to hounds. Although in the present day there are undoubtedly fifty good horsemen or more for one in those days, still we have to thank such men as Meynell, Childe of Kinlet, Lords Jersey, Forester, and Wilton, Messrs. Assheton Smith, Osbaldeston, Dick Christian, Apperley ('Nimrod'), and others of that generation for first showing us what was the true and fearless art of crossing the fine grass districts of the Midlands in the wake of foxhounds, and thus encouraging the breeding and teaching of the best hunters that money could produce. Probably hounds did not go so fast in those days as they do now, after more than a century's careful breeding and rearing; yet the country in those days was much freer from obstructions and difficulties such as railways, canals, roads, and buildings than is the case now; and scent lay better before the days of artificial manures and drainage, so that hounds had less cause for checks than at present. Again, there were not so many fox coverts, and foxes were not so numerous, and therefore stronger individually than they are now, and ran straighter in consequence. One result which the popularity of modern hunting throughout the United Kingdom has brought about is the high state of excellence which has been achieved in the breeding of hounds and horses for the chase. Our hounds originally came from France, and had much of the blood of the old Southern hound in their composition. They have now become more symmetrical and faster, although it may be doubted whether they are so capable of hunting a cold scent, or triumphing over difficulties, as their progenitors. Of late years there has grown to be a fashion in the colour of hounds, the black-and-tan-backed and white-chested hounds, found chiefly in the Belvoir pack, where no doubt the bloodhound blood was extensively used about fifty years ago, being most popular and fashionable. English foxhounds now run from 22 to 26 in. in height; the latter are most used for staghounds. The ruling standard of

the Belvoir hounds is 23 in., but often reaches 24 in. In the large and fashionable hunting countries they usually hunt dog and bitch packs separately. Harriers run from 18 to 21 in., and beagles from 12 to 16 in. There is a distinct breed of hounds, bred in Wales and the mountainous parts of Westmorland and Cumberland, which have rough and wire-haired coats, and are more of the character of otterhounds, but are lighter of body and limb. These hounds have excellent scenting powers and self-reliance, and although their history can be traced back for at least two hundred years, yet they are not considered fashionable, except in their native country.

To realize the extent to which the sport of hunting is carried on in this country, we have only to turn to the statistics before us. There is not a county in England that has not a pack of hounds kennelled within it, and in some of them there are several. Thus, going back to 1885, when the Duke of Beaufort brought out the first volume of the Badminton Library on Hunting, there were 15 packs of staghounds, 172 packs of foxhounds, 139 packs of harriers, and 16 packs of beagles in the United Kingdom. By far the majority of these packs are kept up by subscription, and this subscription in the case of foxhounds runs from £500 to £7000 a year. It must not be supposed that all this money goes into the pocket of the master of the hounds. The hunt has to provide funds for the rent of coverts, the payment for poultry taken by foxes, the damage done to farmers' crops by the hunters crossing their land, and last, and not least, the cost of removal of barbed wire during the hunting months, and its re-erection in spring. During the last thirty years this dangerous mode of protecting and repairing fences has become so much in vogue as to constitute a most serious injury and drawback to hunting, and to its use must be ascribed many fatal and serious accidents in the hunting field. Indeed this use of barbed wire is by far the most serious drawback to the sport that could have been devised, and at present it seems impossible to eradicate, or even to check it.

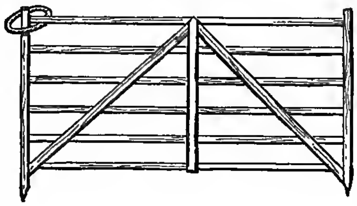
The maintenance of so many packs of hounds causes the sport of hunting to be of great importance to the country; each pack draws together a coterie of sportsmen, owning and riding hunters, and employing grooms and stablemen. Thus the smallest two-days-a-week pack is responsible for from 100 to 300 horses and their attendants, whilst the larger and more important packs, hunting four or five days a week, cause at least 2000 horses and their attendants to be employed. And there is a society of masters of foxhounds, which settles all disputes that may arise in their hunting countries; but luckily disputes are not numerous, and thus the duties of the society are not heavy. There is also a society for benefiting the huntsmen and hunt servants who from accident or age become incapacitated from their employment. This society is a valuable one, and well supported.

It is not only in its direct effects on employment, and the expenditure of capital, that hunting benefits England, Wales, Scotland, and Ireland; it promotes more than any other sport the prowess of horsemanship amongst our youth, and the love of horses, and, above all, renders our country gentlemen and middle classes fond of their homes and interested in their native soil, and binds them together in social ties of sportsmanship such as no other sport can do. It is in no way associated with betting or any such gambling vice, which in these days is held in such obloquy. It promotes rivalry, courage, and discretion, and as a means to health and physical development is unrivalled. A first-rate pack of hounds is worth at least £4000. Even oil paintings of hunting scenes during the last hundred and fifty years, by eminent artists such as Wootton, Stubbs, Ferneley, Ben Marshall, Herring, Alken, and others, are valuable, the finest collection being that in the possession of Sir Walter Gilbey at Elsenham Hall, and at Cambridge House, Regent's Park.

The scene of a day's hunting in any of the midland counties, such as the Quorn, Cottesmore, Belvoir, Atherstone, Warwickshire, Bicester, Meynell, or Cheshire, is such as no other country in the world emulate. Let us take a day in the height of the season with the Quorn at Kirby Gate, a few miles out of Melton Mowbray. There you will see a gathering of from 300 to 400 men and women in faultless hunting attire, arriving, some in carriages or motor cars, and others on horseback; you will witness a superb collection of horses that are to do duty for the day, the majority of which are three-parts thoroughbred; and when all are mounted and following in the wake of the master and his huntsman (a notable man in his profession), encircled by twenty couple of hounds and accompanied by two whippers-in, on the way to draw Gartree Hill covert, you will have a goodly sight such as sportsmen love. This noted covert lies on the fringe of a low hill overlooking the vale of Melton. The concourse of riders, generally denoted as 'the field', is drawn up at a convenient corner, where there is least chance of hindering the fox from breaking covert. The huntsman alone enters the covert with his hounds, the whips being stationed so as to view, if possible, the fox as he steals away. After a few minutes of expectancy a hound's note rings out from the dense blackthorn covert, dedicated alone to foxes. A cheer from the huntsman quickly follows, and is answeed by a momentary increasing chorus of hound music. The effect on 'the field' is magical. Every rein is tightened, every nerve is at attention, and every eye is watching, until a signal comes sweetly down the breeze from the lungs of a whip. The huntsman touches lightly a double blast of his horn; the master gives the word, 'The fox is away!' the hounds are in his wake; the run has begun. We will suppose that our fox chooses the low country, and, crossing the Melton road, finds himself on the great grazing pastures which are part of the Melton steeplechase course. Already 'the field' has become spread-eagled. Scarce a score or more are fairly within a field of the pack. Some are galloping to the right for Wilds Lodge and a bridle road, others are stick-

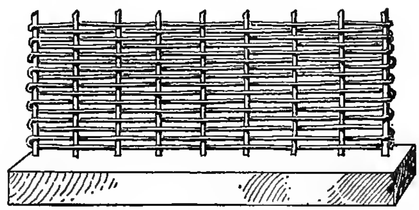
ing to the high road towards Burton; but hounds and the hardest riders forge straight ahead, as if for Melton itself. Then there is a turn in favour of the right-hand division. Burbidge's covert (belonging to the Belvoir) is not entered; Laxton's covert and Berry gorse are passed through. The length of the pursuing crowd is much drawn out as the higher ground is reached and Whissendine Church appears on the horizon. Only the best of those brilliant bits of pink, and the choicest of the black coats and habits, can live with them now as they cap the hill and drop down to the Whissendine brook—a fair bank-to-bank jump, with 14 ft. of water, and a muddy bottom. It has taken toll of many a score in its time, and will do so to-day. Yet a bold man on a bold horse, if he chooses a good sound place, is sure to get over. The chase now momentarily falters as it crosses the Oakham road on the high ground, and still there is nothing but a sea of grass, all in the Cottesmore domain, in front of you. Yes! there are loose horses here and there, and you hear the cracking of ox rails on the landing side of the fences. The pack is running relentless for blood across the Langham vale—those vast pastures of ridge and furrow—with their fox almost in view. Once more they cross the Oakham road, and there is Ranksborough's fine gorse looming on the hillside. The fox tries to reach it, but in vain. Perhaps he feels that its thickets are ill-suited to his panting heart; and as he turns away, those racing, relentless hounds get a view of him, and in another field they roll him over in a style that only such hounds can do. It has been a run of an hour and ten minutes, such as all true Meltonians declare to be superb, and few indeed can boast of having seen it all. Long, indeed, after the huntsman has thrown the dismembered carcass to his hounds, many a battered sportsman and beaten horse keeps dropping in. [R. D. G. P.]

Hurdles.—Hurdles are used for a variety of purposes, but are most in demand for sheep-



Slat Hurdle

Stake



Wattle Hurdle

folding throughout the southern counties of England. Birch, alder, oak, willow, and in fact any coppice wood that can be conveniently split, may be utilized for the making of hurdles, although the indiscriminate use of mixed wood should not be encouraged. Birch hurdles rarely keep sound for more than two years, and cannot therefore be recommended. Ordinary wattled sheep hurdles, or 'close hurdles', are extensively used in hilly districts, because they act as a shelter from the wind in addition to their primary use as a fence. These hurdles, usually 6 ft. in length by 2 ft. 10 in. in height, may be made of split wood solely, or part split and part whole. The quality of the hurdles depends to a great extent on the selection of the 'rods' from which they are made; these should be straight, and as free from knots as possible. Practical experience proves white hazel to be more satisfactory than the red variety. A skilled hurdles maker, doing good work, can make from nine to ten of these hurdles a day (ten hours), which, when sold, realize about 8*s.* per dozen, or £3, 10*s.* per load of ten dozen; while the ordinary rate of pay to the maker is 3*s.* 6*d.* to 4*s.* per dozen. When cut down and trimmed, the rods are made up into bundles of fifty, from six to seven bundles being required to make a dozen hurdles. Furthermore, rods should be cut between Michaelmas and Christmas, and the hurdles made during March, April, and May, for after these months the wood becomes hard and dry. A gate, or 'slat', hurdle is an open hurdle usually made of split oak, ash, or willow having the rough surface and corners shaved. From six to seven spars or slats are used, together with two braces, and three uprights, the whole being securely nailed or mortised together. The two outer or end uprights are sufficiently long to admit of their being driven into the ground, thus avoiding the use of stakes; the heads being held in position by means of shackles. In some districts it is usual to alternate round with cleft wood, the outside uprights being round and provided with metal bands to prevent splitting. This class of hurdle will cost 2*s.* per dozen for making, and are sold at from 11*s.* to 12*s.* per dozen. Barge hurdles, as the name implies, are used for placing in the bottom of barges to ensure goods being kept dry, and to admit air where necessary. These hurdles vary in size according to requirements, but usually contain uprights placed at intervals of 8 in. apart, and when completed are 6 ft. 8 in. in length, the height being 2 ft. 10 in. They are usually made of round wood. Much larger hurdles are made for special purposes, not the least important being for the threshing out of sainfoin seed. Hurdles are used extensively as road foundations in boggy and wet land. After making is completed, it is customary to store hurdles by laying them horizontally in stacks of one load to each stack, for at least six months. This has the effect of shaping them, while the sap is allowed to escape, and warping is prevented to a great extent. When hurdles are

to be stored in stacks for two or more years, they should be well thatched; but if in constant use, or when stored temporarily, they should always be placed in an upright position. The tools required for hurdlemaking are a billhook, a small hatchet, and a mould or small block of wood. The last named is set firmly in the ground, and contains holes at regular intervals, wherein the uprights are placed before the cleft rods are twisted round them. [J. C. N.]

Husbandman, a general term meaning a man who tills or cultivates the soil; a farmer.

Husbandry, the business or occupation of a husbandman or farmer, that is, the tillage and cultivation of the soil, and also associated occupations, such as the rearing of live stock and poultry.

Husk.—Husk may mean hoose or parasitic bronchitis (see HOOSE); or it may refer to the dry thin covering of fruits or seeds.

Hyacinth, the popular representative of the genus Hyacinthus (nat. ord. Liliaceæ), of which

Hyacinth Bulb with offsets

thirty species are known. *H. orientalis*, the progenitor of what is called the Dutch Hyacinth, is a native of countries bordering the Mediterranean. It has been a favourite garden plant in England for at least 300 years, and for more than a century its cultivation in Holland has been an important industry. In the neighbourhood of Haarlem, where the soil is very sandy, the bulbs are grown by the million, peasant farmers and even cottages growing them for sale and export. Although the named varieties number a thousand or more, there is little variation in them, colour and size of flowers being their chief characters. They range from pure-white to the darkest shade of blue, and the spikes, which are about 1 ft. long, bear from thirty to fifty flowers. They are propagated chiefly from offsets developed on mature bulbs that have been cut across the base and placed in sand in a little warmth. The bulb being formed of the fleshy folding bases of the leaves, buds are developed from these cuts (see fig.), and these are removed and planted to be grown into flowering bulbs, which they do in about four years. They are then sold for planting in beds to flower in spring, or in pots or glasses for indoor decoration. They prefer a sandy soil and plenty of moisture while growing. There are districts in England where hyacinth farming could be practised, although it would be difficult to successfully compete with the Dutch, who practically supply the bulbs for the whole world. [W. W.]

Hyacinth.—Parasitic Fungi.—

BULB ROT.—Cultivated hyacinths and other bulbous plants are frequently destroyed in large numbers by several kinds of bulb rot. The most frequent symptom is premature yellowing of the leaves, and the yellow patches becoming covered with an olive-brown mould. On examining the bulbs, black seedlike bodies, the sclerotia of a fungus, will be found on the outer bulb scales (see also ONION and TULIP, PARASITIC FUNGI). Other forms of bulb rot are accompanied by formation of slime in the bulb or flower-stalk; bacteria are present, and are said to cause this rot. *Treatment.*—Many of the difficulties of bulb cultivation are connected with the avoidance of bulb rot. It follows certain classes of soils, especially the tenacious kinds. The best soils may, however, become 'sick', and a change of crop is necessary for several years. If the disease is actually present in bulbs, they should be destroyed. Dusting the bulbs with flowers of sulphur is recommended as a preventive measure.

LEAF RUST. — Several species of rust fungi form rust patches on the leaves of hyacinth and other cultivated species of Scilla. This can be checked by picking off the rusted leaves and using a spray fluid (see FUNGICIDES).

[W. G. S.]

Hybrid, an animal or plant produced from two different species belonging either to the same genus or to different genera. When the species belong to the same genus, the progeny is known as a *species hybrid*, but when they are of different genera, the progeny is called a *genus hybrid*.

Hybridization in Animals.—It is not possible to draw hard-and-fast lines between different degrees of crossbreeding, which may all be arranged on an inclined plane—for they differ simply in the degree of difference between the two parents. We may conveniently use the general term 'hybridization' (crossbreeding, exogamy) when there is a marked difference between the two parents, and when they are not nearly related to one another. But hybridization is to be contrasted with the pairing of nearly related animals (inbreeding or endogamy), and with the pairing of similar animals belonging to the same breed or variety or sub-species (pure-breeding).

There are various degrees of hybridization: between individuals belonging to different *genera*, *e.g.* domestic fowl and pheasant; between individuals belonging to different *species*, *e.g.* capercailzie and black grouse; between different domesticated *races and breeds*, *e.g.* of horses, cattle, sheep, and dogs; between *domesticated races and nearly related wild species*, *e.g.* sheep and mouflon; between representatives of *pure-breeding varieties*, *e.g.* between a yellow mouse and a white mouse. The popular impression that crosses between 'distinct species' are very rare is erroneous; for, apart from the familiar mules, successful pairing is recorded between lion and

tiger, dog and jackal, wild and domestic cat, brown bear and polar bear, American bison and European wild ox, horse and zebra, duck and goose, duck and pintail duck, canary and siskin and other birds, thrush and blackbird, and the list soon becomes very long when we pass to frog and newt and fish, and to backboneless animals such as butterflies.

Hybridization between a domestic race and a nearly related wild species is known in the following and other cases: Domesticated cattle and zebu (with offspring fertile *inter se*), domesticated sheep and mouflon (with offspring fertile *inter se*), goat and ibex, llama and guanaco, dromedary and wild camel, domesticated swine and wild boar. Some would call the results of these crossings mongrels, but not hybrids; it is, however, a question of degree.

Some animals that one would expect to be capable of hybridization show no sexual appetite towards each other. This seems to be true for both sexes in the case of domesticated cattle and the European wild ox (*Bos bubalus*). Animals of different species may sometimes copulate without any hybridization being effected. Thus ram and female goat, or male goat and ewe, may come together, but no result has ever been proved, though often asserted. An emphatic statement in support of the assertion will be found in Wallace's Darwinism (1889), p. 162. The often-repeated assertion of fertile crosses between rabbit and hare is also unproved.

The fertility of hybrids seems to depend in part on the degree of distinctiveness between the parents. The crossing may be readily brought about, the offspring may be a beautiful well-formed animal—but sterile. All the crosses between canaries and other birds are sterile, and mules are almost invariably sterile. We say almost invariably, for there are quite definite statements, such as that of Dr. F. C. Noll that in the 'Acclimatization Garden' in Paris there was in 1873 a fertile cross between a horse stallion and a mule. Crosses between male ass and mule are also recorded. The hybrid of male ass and mare is a mule; the hybrid of horse and female ass is a hinny, which is usually smaller and has more of the donkey about the head than the mule shows.

As we have noted, crossing domesticated races and related wild forms is often successful, and results in offspring often fertile with one another or with the domesticated race. In the case of domesticated cattle and the Indian gayal (*Bos frontalis*) the male offspring are sterile, but the female are not. A case is recorded of a gayal cow served by a zebu bull; the offspring was subsequently crossed with the American bison, the same was done in the next generation. Crossings between domesticated cattle and zebu or American bison or yak have yielded forms which are fertile with the parent types. The same is true in regard to crossing dog and wolf, dog and jackal.

There is much need for more investigation concerning the sterility of many hybrids. It may show itself (1) in atrophy of the essential reproductive organs, (2) in abnormalities in the reproductive ducts, or (3) in more obscure conditions in regard to which we can only shroud our ignorance with the words, 'constitutional incapacity'. Iwanzoff notes that the seminal fluid of hybrids of horse and zebra contained no spermatozoa.

Some hybridizing experiments among lower animals suggest conclusions that should be tested in higher forms. Vernon, working with sea urchins, found that the hybrid showed more of the character of the parent whose sex cells were relatively more mature at the time of fertilization. Some of the results of Standfuss, in regard to Lepidoptera, suggest that the hybrid shows more of the character of the parent whose species is the older, or the more primitive, or the more securely established.

It is possible that many of the results of hybridizing at present obscure may fall into line with what are now known as Mendelian phenomena, but in the meantime it seems useful to distinguish several classes of results. (1) The hybrids may be an intermediate blend of the parental characters, as in mulattoes, finch and canary, carrion crow and hooded crow, and in many plants. (2) The hybrids may show a particulate juxtaposition of the parental characters, but no blend, as in piebald animals, or in a cross between male Lady Amherst pheasant and female golden pheasant. (3) The hybrids may resemble an ancestral form, whose characters have not been recently patent, as in some crosses of pigeons which result in forms like the wild rockdove. (4) The hybrids may be quite different from either parent, new departures, novel variations—'with a character of their own'. (5) The hybrids may exhibit certain (dominant) characters of one parent, the contrasted (recessive) characters of the other parent remaining latent or unexpressed. This is the first step in Mendelian inheritance. See BREEDING, LAWS OF; CROSSBREEDING, HEREDITY, and MENDELISM.

[J. A. T.]

Hybridization in Plants.—The essential feature of the process of sexual reproduction, both in the animal and vegetable kingdom, consists in the blending or union of two sexual cells or *gametes*. In the lowest forms of living things the gametes are similar in size and form, but in the higher plants and animals there is a considerable differentiation between the two. Among animals the male cell is actively motile, and is termed a spermatozoon; the female cell is passive, non-motile, and spoken of as the ovum, egg, or egg cell. In flowering plants the male cells are enclosed within the pollen grains, which are produced by the stamens, the eggs being found in the ovules contained in the pistil of the flower. Except in rare cases, neither of the two sexual cells is individually capable of growing into a new organism.

In normal sexual reproduction the male cell fuses, blends, or mixes with the egg, after which the latter begins a new life, and slowly grows and develops into a new animal or plant. The egg is said to be fertilized by the male cell, and the process in all essential points is the same among animals and plants, the differences being chiefly concerned with the methods by means of which the union is accomplished.

In the case of flowering plants the pollen grain is transferred by the wind or by insects from the stamens where it is produced to the stigma of the flower. Here it germinates, and gives rise to a threadlike tube—the pollen tube —which grows down through the substance of the style of the pistil, and makes its way into the cavity of the ovary below, and eventually into the ovule generally through a minute opening—the micropyle—in the coats or covering tissues of the ovule. The male cell within the pollen grain travels down the tube and into the ovule, where it fuses with and fertilizes the egg, after which the latter grows into an embryo plant, the ovule and walls of the ovary at the same time increasing in size to accommodate it. The ovule becomes the seed.

In plants there are several possibilities in regard to the fertilization of eggs by male cells. They may be fertilized by male cells which have arisen in the stamens of the same flower as that in which the eggs are produced, or by those which have come from stamens of similar flowers borne on other branches of the same plant. Both these are generally described as cases of *self-fertilization*, although perhaps, strictly speaking, the term should be applied to the first example only. It often occurs, however, that the pollen grains of one plant are carried to the stigma of another at a greater or lesser distance away, and what is termed *crossing* or *cross-fertilization* takes place, the eggs and male cells concerned originating on different individual plants.

It is found that before the male cell can effectively fertilize and stimulate the egg of another plant to grow into a new individual there must be a certain affinity between the two sexual cells. The male cell of a geranium will not fertilize the egg of a red clover plant, and the transference of the pollen of an apple flower to the stigma of a plum or cherry does not result in any fertile union.

Similarly crosses do not occur between the dog and cat nor between horses and cattle, the sexual cells being ineffective on each other. As a rule it is found that plants and animals which differ widely in structure and natural descent cannot be crossed; but the amount of difference which will constitute a bar to fertilization cannot be settled with certainty except by experiment, since the real nature and meaning of the limits of sexual affinity are unknown. The term *hybridization* has often been limited to the crossing between animals or plants which are sufficiently distinct to be considered as different species, the resulting offspring being spoken of as a *hybrid*. The offspring popularly known as a mule, obtained by breeding together the horse and the ass, is an example, and hybrids have been produced between the lion and tiger, the parents in both these cases being well-marked distinct species. Similarly in the vegetable kingdom hybrids have been obtained between wheat and rye and between the black currant and gooseberry. For the crosses between races or varieties of a single species the terms *cross*, *cross breed*, *mongrel*, or *half breed* are generally used. For example, the progeny of the Short-horn race crossed with the Jersey race of cattle are cross breeds or mongrels, and similarly the same term would be applied to the cross between the 'red' and the 'white' varieties of cabbage.

Instead of restricting the words 'hybridization', 'hybrid', and 'cross' in this way, it is perhaps better to use the term 'hybridization' in a general sense to include the crossing of any two parent plants or animals between which there is some obvious or marked difference, the offspring being spoken of as a *variety hybrid*, *race hybrid*, or *species hybrid*, according to whether the two parents were considered varieties, races, or distinct species; where the parent organisms belong to different genera, the term *genus hybrid* is used for the offspring.

The characters of the various classes of hybrids are very varied, and few statements of general application can be made in regard to them.

Variety and race hybrids, as a rule, are more vigorous in constitution, possess greater vitality, and often grow to a larger size than either of the parents. They are generally very fertile, producing abundant offspring. Well-known examples are met with among sheep, cattle, fowls, and other farm stock, such mongrels or crosses possessing improved stamina and greater fecundity than the inbred parents. Numbers of variety hybrids are seen among flowers, fruits, and vegetables in the garden.

Many of the characters of the parents and their hybrid offspring obey Mendel's law of inheritance (see art. MENDELISM); indeed the Mendelian phenomena have been determined almost entirely by a study of variety and race hybrids of plants and animals.

Reciprocal crosses are usually found to give the same result; that is, the offspring obtained by crossing the female of one species with the male of a second is the same in colour, form, and other characters as that produced by fertilizing a female of the second kind with the male of the first: A♂ × B♀ gives the same result as B♂ × A♀ (the symbols ♂ ♀ standing respectively for male and female). There are a few instances recorded where crossing one way gives rise to hybrids which are at first weaker and more difficult to rear than hybrids between the same species crossed in a reverse way; but when care is taken to rear both forms they are found to be quite similar in morphological features. It was formerly believed that there were considerable differences between reciprocal crosses, and that the offspring followed the colour and form of the male parent, while the constitution was controlled by the female parent; but careful examination of a large number of hybrids shows that no such rule exists in reality, there being as many examples against this statement as there are in support of it.

Typical species hybrids are much less common than variety hybrids. Vast numbers even of closely related kinds of plants or animals do not cross; for some unexplained reason the male cells of one are unable to impregnate or fertilize the eggs of the other species. Although there are exceptions to the rule, in the majority

of cases it is found that where crossing does occur the hybrids are either altogether sterile or much less fertile than the parents. The sexual organs and the production of gametes are abnormal and imperfectly developed, perhaps more especially so in the male progeny. The spermatozoa and pollen grains of species hybrids are more often defective than the ova or eggs. Male and female mules have never been known to produce offspring when crossed with each other, but the females will sometimes breed with males of either parent species. The same peculiarity is not infrequently observed among species hybrids of flowering plants, the ovules being fertile with pollen of either parent, but not with that of the hybrid itself.

Although species hybrids do sometimes occur among animals and plants in a wild state, they are comparatively rare. Many, however, have been produced under man's control.

Among plants many more reputed species are found to cross, and in the offspring all degrees of fertility are seen; some of the hybrids are remarkable for their fertility, others are absolutely sterile, and between the two extremes intermediates of all grades are met with. It must be borne in mind, of course, that the meaning of the term 'species' is a matter of opinion, and its limits to a great extent a matter of convenience and taste; it is therefore possible that many so-called distinct species are much more nearly related by descent than is suspected. Some of the earlier hybridists found so many of the crosses between well-differentiated species to be sterile, or nearly so, that they were inclined to make the diminution of fertility a test of specific difference between the two plants concerned in the cross; but the views of systematists would have to be much modified if this view is to be maintained. The nature of sexual affinity is unknown, and at present all that can be said safely in regard to the subject is, that some species hybrids are quite fertile, while others are sterile, without any apparent reason.

Few species hybrids among animals are of any economic value, and the same may be said of fruits and vegetables. Many decorative plants, however, are the product of hybridization of distinct species. The majority of the animals which are of service to man, and the fruits and vegetables which he cultivates, are variety hybrids, and even among the plants which are grown for ornamental purposes the larger number belong to this class. The mule is one of the very few useful species hybrids; but the Shorthorn, Hereford, Red Poll, and other breeds of cattle, and the breeds of horses, sheep, and pigs, are chiefly the product of the crossing of varieties. Similarly most of the garden varieties of beans, peas, cabbages, and other vegetables, as well as many fruits, are variety hybrids. Among garden flowers both kinds of hybrids are well represented, as is evident from a study of the cultivated orchids, roses, lilies, begonias, irises, narcissi, lilacs, and many other genera.

In the breeding of new varieties of animals and plants, and in the improvement of old ones, crossing is one of the most potent aids to success. By its means, variations are induced from which the breeder can select the forms which he needs to establish a new strain or race. With a knowledge of Mendel's laws of inheritance the task of selection is greatly reduced, and the end in view, if attainable at all, can be more rapidly and certainly reached. Desirable characters which are only met with in two or more plants or animals can often be combined in one individual by suitable crossings. For example, tender varieties of apples, plums, oranges, and other fruits, which are unable to withstand the severe winters of certain districts, may be 'improved' by crossing with hardy varieties. The physiological peculiarity on which hardiness depends may be imparted to offspring of a tender variety by suitable hybridization, and selection will finish the work,—selection alone being, of course, powerless to initiate the variations upon which it is exercised.

The northward range of growth of the citrus fruit in the United States of America has been considerably extended by hybrids obtained through crossing the sweet oranges with the cold-resistant *Citrus trifoliata* from Japan. Forms of *Rhododendron arboreum* have been rendered more hardy by crossing with *R. catawbiense*; and the delicate *Tritonia aurea* has given rise to hardy hybrids by crossing with *Montbretia Pottsii*. Resistance to drought and other adverse conditions of soil and climate have been dealt with in the same manner. The introduction of the Kieffer pear, a hybrid between the common European pear (*Pyrus communis*), which will not thrive in the southern States of America, and *Pyrus sinensis*, has extended the profitable growth of pears very much farther south than was formerly possible.

Size, earliness and lateness, flavour, and many other characters have been altered and improved, and power of resisting disease has been conferred on susceptible varieties by hybridization. The large strawberries of our gardens, so very different from those growing wild, are hybrids between two or three species. Improvement of the sugar-yielding capacity of the sugar cane has been made in the West Indies and other parts of the world, and its resistance to disease has been increased by hybridization and selection. It is hoped that by the same means new varieties of wheat will be obtained which possess the great yielding power of the English Squarehead types combined with the high milling quality of the Canadian and eastern European kinds.

When an artificial cross is to be made between two plants, it is necessary to take great care that no pollen except that of the intended male parent shall reach the stigma of the flower which is to be the seed-bearer of the cross. To ensure this a definite routine such as the following should be adopted by the hybridist.

1. First select the flower which is to be the ultimate seed-bearer. This must be done while it is yet in bud, before the anthers have ripened or shed their pollen. As many plants are inclined to develop and scatter ripe pollen in the interior of their flowers before the latter are

open, an examination must be made of several buds in order to learn the peculiarities of the species to be crossed in this respect. Search should also be made for the presence or absence of minute fly and beetle larvæ, which sometimes penetrate unopened flowers and set free the pollen.

2. Carefully pull apart the sepals and petals of the flower with small forceps, and then emasculate it by removing the stamens with scissors or forceps, taking care not to bruise the anthers and set free the pollen within them, or damage the delicate style and stigma. When the stamens have been removed, cover up the flower in a paper bag, so that no pollen can be carried to the stigma by the wind or by insects. In those cases where it is known that the pollen is transported only by means of insects, the flower may be covered with gauze or muslin.

The pollen of a plant can only germinate properly and penetrate the stigma and style when the stigma is fully developed and in a receptive condition, in which state it frequently exudes a sticky liquid, or shows characteristic papillæ or hairlike extensions of its surface. Emasculation should be performed before the flower is ready to receive pollen, after which it must be covered with gauze or a paper bag for two or three days until the stigma is fully developed, which may be determined with sufficient accuracy by examination with a pocket lens, after a study of the stigmas of other flowers of the plant in various stages of development.

3. The pollen-bearing flower, or a piece of the inflorescence bearing several flowers, should be selected at the same time as the seed-bearer is chosen, and enclosed in a paper bag, in which it is allowed to ripen its pollen without fear of being contaminated with pollen from outside. It is not satisfactory, although frequently practised, to use pollen from flowers which have opened in an ordinary manner exposed to the air, since in such cases there is no certainty that the pollen to be used for the crossing is pure and unmixed.

4. The pollen obtained in the above manner should be transferred to the clean stigma of the other parent of the desired cross. Various ways of doing this will suggest themselves to hybridists. In some cases it may be shaken from a flower of the male parent into a watchglass, and the emasculated flower of the female parent bent down so that its stigma comes into contact with the pollen; or a stamen with open anthers may be removed with forceps, and the pollen from it carefully rubbed on the stigma. The use of a paint brush is not to be recommended where accurate work is desired, except in the cases, perhaps, where large numbers of the same cross are wanted.

5. After the application of the pollen, the flower operated upon should be enclosed again in its gauze or paper covering, and left until the pod or ovary shows evident signs of the growth of seeds within it, or until the seeds are ripe.

6. To prevent error and uncertainty, careful records should be kept of the parents of the cross, and the flowers which have been impregnated should be accurately labelled. [J. P.]

Hydatids, an old term applied to the bladderworm stages of tapeworms. Thus a pig with the bladders or cysts of *Tænia solium* in its muscles was said to show 'hydatids', just as at a later date it was said to contain *Cysticercus cellulosæ.* But as both these terms date from a time when it was not known that bladderworms are stages in the life-history of tapeworms, they might be abandoned without any loss to science. [J. A. T.]

Hydrangea, a genus of Saxifrageæ, comprising upwards of thirty species of evergreen or deciduous ornamental shrubs or small trees, natives of Asia and the United States. The species that deserve general cultivation out-of-doors in this country may be reduced to three, and of these *H. hortensis*, the common Hydrangea (2 to 3 ft., flowers variable in colour), introduced from China in 1790, will only succeed in the warmer localities. There are numerous garden varieties of this plant, Thomas Hogg (pure-white flowers) being one of the best. These are extensively cultivated in pots, being then restricted to the production of two or three large flower-heads, for which they require liberal feeding and a great deal of water. *H. paniculata*, from Japan, which has large upright corymbs of white flowers produced in late summer, is quite hardy. The flowers of the var. *grandiflora* are sterile, and this last is benefited by severe pruning. This plant is largely grown for forcing in pots, and used for room decoration in spring. *H. petiolaris* (*scandens*), Japan, is an ivylike trailing species with white flowers borne in flat-topped cymes. Hydrangeas like a very rich soil with plenty of water. The flowers are sometimes blue, particularly in certain soils, and efforts are directed towards their being constantly so; the use of alum in the water and the introduction of iron into the soil are said to produce this result. Propagation is usually effected by cuttings of the young shoots. [W. W.]

Hydraulic Ram, an apparatus by means of which the kinetic energy of a column of water falling through a small height is utilized in elevating a portion of that water to a greater height. In its simplest form, the ram, as represented diagrammatically in fig. 1, consists of a supply pipe P, a valve box, B, containing a waste valve V_1 and a discharge valve V_2; an air vessel A, and a discharge pipe D. The waste valve V_1 opens inwards and the discharge valve V_2 outwards. Through this latter valve the water is delivered, intermittently, into the air vessel A, from which it flows in a steady stream up the discharge pipe into the cistern C.

The principle upon which the hydraulic ram acts is as follows: Suppose the valve V_1 to be opened, then water will escape past it and a flow will be set up along the supply pipe P. Under the influence of the supply head, h, the velocity of this flow will gradually increase until the dynamic pressure acting upon the valve becomes sufficiently great to overcome its weight and rapidly close it. By this time, however, the column of water in the supply pipe has gathered considerable momentum, so that in being brought quickly to rest it exerts great pressure, which, forcing back the delivery valve, enables a por-

tion of the water to enter the vessel A. Then, as the water comes to rest, the excess pressure in A over that in B forces the valve V_2 down on its seat, carrying with it the water below it and thus causing a flow in the opposite direction. During this 'rebound' of the water the pressure in the valve box falls below that of the atmosphere, so that the valve V_1 opens and the whole cycle, which may only take a fraction of a second to complete, recommences.

A small hydraulic ram, capable of raising 300 gal. of water per day of twenty-four hours to any height up to 1000 ft., is shown in fig. 2. Rams of all capacities up to 500,000 gal. per day are constructed, and have proved successful and economical water raisers for domestic, irrigation, and many other purposes. Their efficiency or ratio of the work done by the ram to the energy expended by the falling water is, however, not high, and rapidly falls as the ratio of H, the height to which the water is raised, to h, the supply head, increases. If W be the weight of water used, w the weight raised, h the supply head, and H the height pumped, then: efficiency $= \frac{w\,H}{W\,h}$. For different values of H ÷ h, Rankine gives the formula—

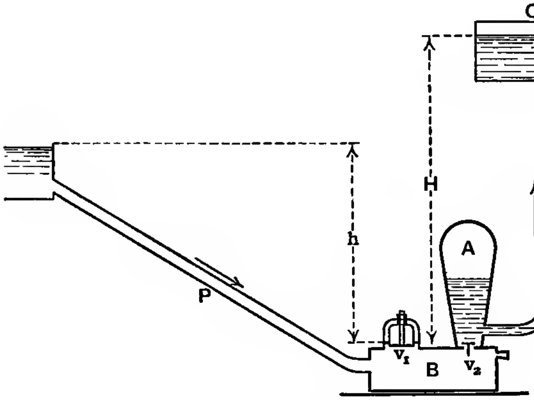


Fig. 1

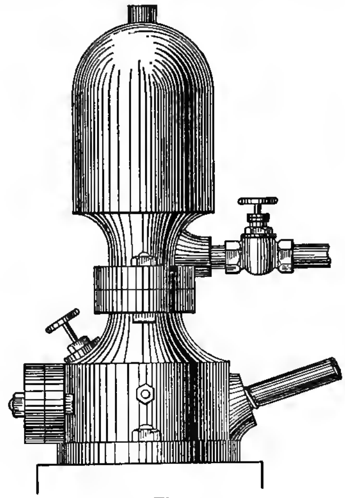


Fig. 2

$$\text{Efficiency} = 1{\cdot}12 - {\cdot}2\sqrt{\frac{H}{h}} \text{ approximately.}$$

Thus, if H = 160 ft. and h = 10 ft., according to the above formula we should have—

$$\text{Efficiency} = 1{\cdot}12 - {\cdot}2\sqrt{\frac{160}{10}} = 0{\cdot}32.$$

The above formula, though not of much value for determining exact efficiencies, serves to show how rapidly the efficiency falls off as the ratio of H to h increases.

Hydraulic rams working upon the same principle as the above, but slightly modified in constructional details, are used for pumping pure water from one source while using, as motive power, a stream of impure water from another. [H. B.]

Hydrocele. — Dropsy of the scrotum, or hydrocele, is a sequel to orchitis or inflammation of the testicle (which see), rather than a disease in itself. Rams are specially subject to it, their testicles being large and pendulous and in frequent contact with ewes during the tupping season. Stallions and bulls, boars and dogs, are also occasional victims of this trouble. When the fluid accumulates to any great extent, the weight of the purse interferes with the animal's movements, and is liable to be chafed and the skin rendered sore. Sexual appetite is diminished, or service altogether refused, and it becomes necessary to tap the purse from time to time. This is done by an aspirator, previously sterilized, or by a fine trochar and canula, after which a considerable period of usefulness may be secured before refilling again necessitates interference. Iodine injections are calculated to excite absorption, and animals not needed for procreative purposes are radically cured by castration. [H. L.]

Hydrocephalus. — An excessive amount of fluid in the cranium is known as water on the brain, or hydrocephalus, and is of not infrequent occurrence in calves and other animals. It is sometimes necessary to puncture the skull in order to deliver the fœtus. Foals, calves, lambs and other creatures capable of being born with this deformity very commonly outgrow it, the fluid being absorbed, and the bones falling into natural proportions. Small doses of bromide and iodide of potassium with iron favour the process, and monstrosities of this type should not be destroyed without consideration of the possibilities of recovery or return to the normal. [H. L.]

Hydrocyanic Acid and Cyanides.— Hydrocyanic acid (HCN) is, when pure, a mobile colourless liquid which is very easily volatilized. The dilute hydrocyanic acid of the British Pharmacopœia is a 2-per-cent solution of the acid in water. What is known as Scheele's hydrocyanic acid is a solution of about 4-per-cent strength. The pure anhydrous acid is seldom seen. Hydrocyanic acid is commonly called

prussic acid. It is a most powerful poison, either when swallowed or when inhaled with air. About 1 grain of the pure acid, that is about one drop, or its equivalent of the dilute acid, is sufficient to cause the death of an adult. Its action is very rapid, so that when a sufficient dose is taken it causes death in a few minutes. Its action is so fearfully rapid that it is apt to be exaggerated, and it is commonly said that it causes death *instantaneously*. It poisons the lower animals and nearly all plants as well as the higher animals, but its action on the lower animals is not so rapid and intense as it is upon mammals. Plants are still less susceptible to its poisonous action.

Hydrocyanic acid is a very weak acid. It forms salts called cyanides, of which the best known is potassium cyanide (KCN). Both hydrocyanic acid and potassium cyanide have a peculiar characteristic and very penetrating odour which is not unpleasant. Hydrocyanic acid is very readily turned out of its salts by other acids. Even carbonic acid is able to liberate it from potassium cyanide.

Compounds which contain hydrocyanic acid, combined with glucose, sugar, and other substances, and which are known as cyanogenetic glucosides, are found in many plants. These, when acted upon by substances called enzymes, which are commonly found in the plant along with the glucoside, break up, liberating hydrocyanic acid. A well-known glucoside of this kind is amygdalin, which is found in bitter almonds, peach, plum, and cherry kernels, laurel leaves, and various other parts of plants. About 1½ to 2 oz. of bitter almonds yield a fatal dose of prussic acid. Oil of bitter almonds contains from 5 to 12 per cent of hydrocyanic acid, to which its odour and flavour are partly due.

Another cyanogenetic glucoside, phaseolunatin, is found in beans of the Phaseolus or kidney bean family, and especially in *Phaseolus lunatus*. This bean is imported as Burma or Rangoon beans and as Lima beans. Serious outbreaks of poisoning among cattle have been caused by the use of a variety of these beans known as Java beans. These deadly beans contain considerable quantities of the glucoside, some samples yielding over 0·1 per cent of prussic acid. Ordinary Burma beans only contain very small quantities of the poison, and no trouble is known to have arisen from their use. It is curious that the same prussic acid yielding glucoside is found in linseed and in young flax plants (Dunstan, Henry and Auld, Proc. Roy. Soc. 1903, lxxii. 285). The quantity found in linseed, though smaller than that in Java beans, is considerable, but no case of prussic acid poisoning is known to have occurred from the use of linseed or linseed cake as food. Poisonous bitter cassava contains the same glucoside in considerable quantity.

Hydrocyanic acid is used as a fumigating agent (see FUMIGATION) to destroy the insect pests of fruit trees, and of young plants and bushes, such as nursery stock which is being transplanted. In some cases it is used to clear greenhouses, flour mills, granaries, and dwelling houses of insect vermin. Where growing fruit trees and bushes are treated they are covered with a movable tent of air-tight material, under which the prussic acid is liberated. Quite large bushes are treated in this way. The acid poisons both biting and sucking insects, and is very effective against many pests, such as scale insects, which it is difficult to reach by means of sprays. Where it is possible to use it, it is generally held to be more effective than spraying.

To obtain hydrocyanic acid for fumigation purposes, potassium cyanide is treated with diluted sulphuric acid. They are used in the proportions of 1½ fluid oz. of strong sulphuric acid mixed with 3 or 4 oz. of water, to 1 oz. of potassium cyanide. These quantities generate sufficient hydrocyanic acid to fumigate a space of from 100 to 200 cu. ft. It is sufficient to pour the sulphuric acid on to the cyanide, or to drop the cyanide into the acid, to cause the prussic acid gas to be produced. A glass or earthenware vessel should be used. It is generally sufficient if the plants are exposed to the action of the acid for an hour.

The greatest care should be taken not to breathe even small quantities of the vapour. Both the gas and the potassium cyanide are deadly poisons. The cyanide should be lowered into the acid, or the acid poured on to the cyanide by some mechanical arrangement operated from the outside. The operator should on no account enter the chamber or greenhouse which is being fumigated until it is thoroughly cleared of the prussic acid fumes. While it is being cleared, he should keep in such a position that the wind will carry the fumes away from him. See arts. FUMIGATION and INSECTICIDES.

[J. H.]

Hydrogen is the lightest element known. It is 14·43 times lighter than air, and has a specific gravity of 0·0693 (air = 1); for this reason it is the gas used for filling balloons. It occurs only in small quantities in the free state. Small amounts exist in volcanic gases, and in gases escaping from petroleum wells. The atmosphere contains 0·02 per cent. It is produced also in small quantities in the anaerobic fermentation of vegetable and animal matter; it is thus found in intestinal gases, and occasionally in the breath. The sun and certain stars contain enormous masses of uncombined hydrogen.

In combination with other elements, hydrogen exists abundantly in nature. It forms one-ninth of the weight of water. It is a constituent of all known acids, the hydrogen of the acid being replaced by the base in the formation of salts. It is also a constituent of almost all organic substances: in combination with the element carbon it forms the great and important group of substances called hydrocarbons; united with nitrogen it forms the base ammonia. The organic components of the dry matter of plants all contain hydrogen. Combined with sulphur it forms the characteristic gas, sulphuretted hydrogen. [R. A. B.]

Hydrolysis is the term applied to the property many substances possess of taking up one or more molecules of water when boiled with dilute acids, or when acted upon by some enzymes with formation of substances with

different chemical properties and composition. Both organic and inorganic substances are included among the bodies which undergo hydrolysis. Among the organic substances the splitting up of some of the carbohydrates by hydrolysis is perhaps the best-known example; thus cane sugar when boiled with dilute mineral acid takes up one molecule of water and splits into two sugars, as seen in the following equation:—

$$\underset{\text{Cane sugar.}}{C_{12}H_{22}O_{11}} + H_2O = \underset{\text{Grape sugar.}}{C_6H_{12}O_6} + \underset{\text{Fruit sugar.}}{C_6H_{12}O_6}$$

The mixture of the two sugars is called invert sugar, and the process may likewise be termed inversion. The conversion of starch into sugar when boiled with dilute acids is another typical example:—

$$\underset{\text{Starch.}}{C_6H_{10}O_5} + H_2O = \underset{\text{Grape sugar.}}{C_6H_{12}O_6}$$

As stated above, enzymes exist in both animal and vegetable cells, and capable under suitable conditions of bringing about hydrolysis. Thus the enzyme invertase hydrolyses cane sugar to invert sugar; the enzyme ptyalin, found in the saliva, hydrolyses starch into sugar; and the enzyme diastase converts starch into malt sugar. The enzymes are fairly stable bodies, and can be extracted from plant and animal tissues readily without any loss of their hydrolytic property. They are the bodies which account for many of the hydrolytic changes proceeding in seeds at germination and in foods during digestion. They are widely distributed in nature, and numerous other examples could be stated of the nature of those already mentioned. Besides carbohydrates, proteids undergo hydrolytic dissociation into simpler bodies, namely amino acids. These changes arise in the proteids stored in seeds during germination and in food during digestion. The proteid egg albumin, or white of egg, splits up into a mixture of eight amino and diamino acids. Other proteids decompose similarly, either by boiling with dilute acids or by the action of enzymes. Investigation into the identity and proportion of the acids produced by different proteids on hydrolysis has thrown much light upon the constitution of proteids in general. Many inorganic salts on boiling with water, also hydrolyse; thus—

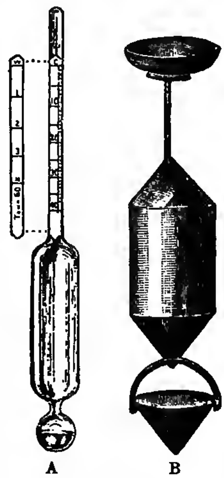
$$Na_2CO_3 + H_2O = NaHCO_3 + NaOH.$$

Some ammonium salts do the same. Fats on boiling with mineral acid hydrolyse into glycerine and fatty acids. Numerous other examples of hydrolyses are known. [R. A. B.]

Hydrometer is an instrument used for determining the specific gravity of liquids either heavier or lighter than water. This method of determining the specific gravity is not as accurate as that of the specific-gravity bottle, but it has the advantage of being a rapid method, and the errors are not large enough to prevent its general use in the arts and in many industries. There are several kinds of hydrometers.

The common hydrometer consists of a hollow glass cylindrical or spherical tube, ending in a small bulb weighted with mercury, so adjusted as to make the instrument float vertically in a liquid; the upper part of the tube is made into a long thin hollow neck containing a scale, graduated either to give actual specific gravities, or the percentage amount of solids in solution.

The working of a hydrometer is based upon the fact that, when the instrument is placed in a liquid, it sinks until it has displaced a quantity of liquid equal to the weight of the hydrometer. It will then float in a position of equilibrium. When placed in liquids of greater density it will not sink so far as when immersed in liquids of lesser density, for in the latter case it will sink deeper because a larger volume of liquid has to be displaced before the weight of the instrument is supported.



A, Lactometer. B, Nicholson's Hydrometer

Hydrometers are made for taking the specific gravity of liquids either lighter or heavier than water. For taking the specific gravity of liquids lighter than water, the graduations on the hydrometer read highest at the base of the neck and decrease as they ascend the neck; conversely for liquids heavier than water. Some hydrometers are made to read difference of ·001 in the specific gravity of liquids. Such instruments are in general use for taking the specific gravity of milk and are called lactometers. The specific gravity varies with the temperature, it decreasing with increase of temperature. Hydrometers are generally only accurate for reading the specific gravity of liquids at the temperature for which they have been graduated. Corrections in specific gravity for temperature can, however, be obtained for the more expensive hydrometers, the necessary corrections being supplied on printed tables.

Metal instead of glass hydrometers are in use for determining the strength of alcoholic liquors. Special hydrometers are also made for reading the specific gravity of sugar and other solutions. Brix, Baumé, and Twaddel's hydrometers are in general use in technical industries. For conversion of degrees Twaddel and Baumé into actual specific gravities, and for temperature and other corrections, tables are given in most books on applied chemistry.

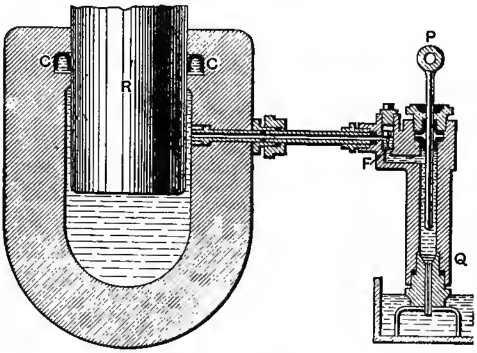
Nicholson's hydrometer consists of a cylindrical metallic bulb, to which a thin stem is attached carrying a cup or tray on which weights can be placed. Below the bulb hangs another tray, weighted with mercury, and so adjusted that the instrument will float vertically. There is a mark on the stem where the

instrument floats in distilled water. For liquids of greater specific gravity, weights are placed on the pan until the mark on the neck corresponds with the level of the liquid—the weights added give directly the specific gravity. Nicholson's hydrometer can also be used for solids. Thermo-hydrometers and lactometers are made for reading the temperature and specific gravity at the same time.

In using hydrometers care should be taken that air bubbles are not adhering to the sides when the hydrometer is floating in the liquid. [R. A. B.]

Hydrophobia, the name given to the disease in human subjects which is called rabies in dogs and other animals. See RABIES.

Hydrostatics, the science of the equilibrium of fluids. Fluids are divided into liquids and gases, of which the former are only very slightly compressible, while the latter are extremely so. Gases or compressible fluids are



Hydraulic Press

further distinguished from liquids, or incompressible fluids as they are called, by the property they possess of expanding indefinitely when permitted to do so.

Fluids differ from solids in being incapable of resisting a change of shape; they may offer a *yielding* resistance, but so long as a distorting force acts upon a fluid it will continue to undergo a change of form. This property, which all fluids have, more or less, of offering a *yielding* resistance to change of form is called *viscosity*. Some fluids, such as gum, shoemaker's wax, tar, &c., possess this property to a very high degree; while others, such as gases, ether, water, &c., are only very slightly viscous. When a fluid is at rest, therefore, there can be no distorting forces acting—that is to say, there can be no tangential forces acting either over a bounding surface of the fluid, or over an imaginary surface of separation between two portions of the same fluid. In other words, *the pressure of a fluid at rest is everywhere normal to the surface upon which it acts.* From this law it follows at once that the intensity of the pressure at any point of a liquid is proportional to the depth of the point below the free surface of the fluid.

Another important property common to all fluids is this: 'that if a pressure of a given intensity be applied to the fluid at any point, that pressure will be transmitted to every part of the fluid, and in every direction, with undiminished intensity'. The hydraulic press, the hydraulic jack, the hydraulic accumulator, &c., are based on this principle. Thus, in the hydraulic press partly shown in fig., as the plunger P is raised water is drawn from the well through the valve Q into the pump cylinder; but when the plunger descends the valve closes, and the water is forced into the large cylinder containing the ram R. Now, in the example, if the area of the ram is 250 times that of the plunger, then a force F acting upon the plunger causes a pressure = 250 F to act upon the ram. [H. B.]

Hydrothorax literally means water in the chest. See PLEURISY.

Hygiene of the Farm.—Hygiene, as defined by Parke, the founder of modern hygiene, is the science which aims at 'making growth more perfect, decay less rapid, life more vigorous, and death more remote'. It comprises, then, the knowledge and observance of the laws which make for the preservation of health. The animal body is subjected to a constantly changing environment, changes of food, housing, climate, and work; there are also great changes taking place in the body itself—at the time of weaning, changes of the teeth, sexual development, increasing age, reproduction and parturition. With all these varying conditions there is constant need of some readjustment of function or structure of some part of the body. If the readjustment takes place, health is preserved; but if not, then the changed environment is harmful, and is taking away from the health of the animal. This action and reaction between the body and its surroundings are constantly going on, and the power possessed by the body of accommodating itself to new and unnatural conditions is very great, provided, as a rule, that the change is a gradual one. It is the province of this article to indicate those rules and that procedure which are necessary to safeguard the health of farm animals, and, in the space available, to deal with as many phases as possible in the lives of these animals, pointing out the possibilities of disease incidental thereto.

HOUSING.—Among the many circumstances affecting the health of farm animals, the character of the buildings they inhabit must be considered of great importance. There are certain principles to be adopted and conditions to be fulfilled in all buildings used for the purpose of housing animals if health is to be maintained, and the more important of these must be discussed. The *site* should be dry and well-drained. Whatever the plan of the building, ample *cubic space* should be provided for the class of animal to be kept therein. A plentiful supply of fresh air is essential for health, and a definite quantity is required per hour for the members of each species. In the case of the horse, about 10,000 cu. ft. of fresh air per hour is the amount required to sufficiently dilute the carbon dioxide exhaled from the lungs of each horse, so as to keep the stable air passably pure. This quan-

tity of air must be provided without subjecting the inhabitants of the stable to violent draughts, and so it is found impossible to completely change the air of the building more than six times per hour. This simply means that the cubic space for each horse must be $\frac{10,000}{6}$ = 1666 cu. ft., or as a practicable minimum 1500 cu. ft. For town cowsheds the Second Royal Commission on Tuberculosis recommended a minimum space of 800 cu. ft. per cow, and it would be well if this were adopted in all new cowsheds, country as well as town. Given sufficient cubic space, and an open roof, *ventilation* is an easy matter. Fodder lofts over stables and cowsheds are to be avoided if possible. If they must be used, they should on no account communicate freely by means of shoots or trapdoors with the building below, for the heated impure air, laden with the exhalations from the animals and with gases from excreta and litter, finds its way direct to the loft, and the fodder is soon saturated with it, so losing all freshness and sweetness. Ventilation is provided by a series of inlets, such as perforated bricks or Tobin's tubes arranged 2 or 3 ft. from the ground in the wall behind the animals in a single-row stable, or just above each stall division in a double-row stable, and also other bricks at the eaves of the building. The *windows*, preferably of the Sheringham valve type, should be made to open, and they will supplement the permanent inlets. Foul air should be drawn out of the building at the top of the roof ridge either by means of extracting cowls or louvred openings. The total area of the available inlets for one horse should be about 1¼ sq. ft., with outlets 1 sq. ft. These openings may be too much in very cold or windy weather, whilst in summer windows and doors will have to provide for extra air entry. Windows on opposite sides, with doors at the ends of the building, provide an ideal arrangement. A building can rarely be too *light*; sunlight is a potent germicide, whilst darkness and disease go hand in hand. The old-fashioned notion that horses kept in a dark stable showed better action on being put in harness is quite exploded, and the advantages to health of plenty of light are great. In addition a well-lighted building must be kept clean, for inspection is easy, and neglected corners are at once seen by the critical owner. To avoid too much glare of the sun in a light stable it is well to have the walls coloured some pale shade and not quite white. The *temperature* of the building is of some importance, and in stables and cowsheds should be about 55° F. An overwarm stable certainly predisposes the animals in it to colds and chills, especially if the warmth is obtained by sacrificing the ventilation. In cowsheds a higher temperature may improve the milk yield, but it will not increase the vitality of the cows and their ability to withstand disease. The *floor* of a stable is a matter of concern. A good floor should be durable, impervious to moisture, not slippery, easy to clean, and as cheap as possible. Probably the best material is some form of vitrified brick, and one should be selected which will *wear rough*. The bricks are laid on a concrete bed which has been sloped to allow of drainage, and are grouted with liquid cement. Where the brick edges are bevelled or chamfered, the pattern should be so arranged that the grooves will slope towards the drainage channel. The *drainage* should in all cases be on the surface and not subsoil. If possible, no traps or gullies should be allowed inside the building. A short surface channel in each stall should run back to join a rather wider channel running behind the row of stalls and conveying its contents through the wall of the building, to discharge over a trapped gully outside. A slope having a fall of 1 in 60 is sufficient in the stalls, and 1 in 100 or 120 in the channel running lengthwise of the stable. If the building is too long for a single channel to get fall enough, a series of short channels (one for each four or five stalls) must lead off from the main one and through the wall behind the stalls to gullies outside. The advantages of surface drainage are its cheapness, the ease with which it can be inspected, and the fact that there is no chance of sewer gas entering the building, and no need under any circumstances to take up the stable floor to inspect drains. Drainage itself saves litter, conduces to cleanliness and health, and allows for the building being swilled out with water from time to time. The *walls* of buildings are best rendered with cement, unless tiles or glazed bricks can be used; and there are various enamel or glazed paints which can be used to give a surface as impervious and cleanly as that of glazed bricks. The value of an impervious and washable wall surface is very great both in stables and cowsheds. For ceilings, or where paint cannot be used, limewash has antiseptic properties, and is so cheap and cleanly that it should be used often. *Fittings* of wood should be avoided, and where possible either iron or earthenware mangers should certainly be used, for in many contagious diseases discharges from the mouth and nose are infective. In cowsheds iron *stall divisions* are the best, whilst in stables iron frames with wood battens slotted in are preferable. The stall division should stand just clear of the floor by about 1 in. to allow of ventilation and drying of the floor. A good *water supply* is all-important, and a good arrangement is to have a supply pipe running the length of the building in front of the mangers, with a connecting pipe to the water trough (for cows, one between two) in each stall. One or two standpipes behind the stalls are extremely useful for attaching a hose. The position of the *manure pit* should be considered in relation to the position of windows and ventilators. It should be as far away as convenient, and so constructed as to drain away from the building, and so that it can be completely emptied and cleaned out, say after an outbreak of contagious disease. *Pig sties* are often the most insanitary buildings on a farm, and the pig is in consequence thought to be a dirty animal. This is not so, and if pig sties are provided with a sound brick floor there is no difficulty in keeping them clean. Where the trade in pigs is a large one, and new pigs are

often being bought on to the farm, swine fever is almost certain to break out sooner or later. In order to keep it within as narrow bounds as possible two things are necessary, viz. the isolation of each pig sty by means of an impervious partition, and the absence of rats and mice from the piggery.

It is advisable, before leaving the subject of buildings, to point out the advantages of—nay, the need for—an *isolation box* for sick horses or cattle. In connection with any stud such accommodation should always be provided, and in the least-frequented part of the ground. A sick box should be larger than an ordinary box, with rounded corners, wide doorway, movable manger and fittings, plenty of light (artificial as well as daylight), and good ventilation. A room alongside for an attendant is often of great service. In the case of an outbreak of disease a small stable or row of boxes has often to be given up for the purpose of hospital and isolation accommodation.

Food.—From a business point of view, no subject is more important in connection with farm animals than the one of food and feeding. The various foods are nutritive in proportion as they contain proteids, fats, and carbohydrates in a digestible form, and of these proteids are most important because they are very essential. These *proteids*, albuminoids, or flesh formers are complex in structure, contain the elements carbon, hydrogen, oxygen, nitrogen, and sulphur, and besides supplying heat and energy when assimilated, they and they alone are capable of making good the muscular (and other proteid) tissues broken down by wear and tear of the body machine. During growth proteids are especially necessary for building up the tissues of the young animal. The *fats* and *carbohydrates* are extremely valuable food principles, and, oxidized in the body, they give rise to heat and energy, or if in excess of the requirements, are laid down in the form of fat. They are of similar use in the body, so that a deficiency of one may be made up by an excess of the other. For this reason the total fats and carbohydrates in a food may be added together and stated in terms of digestible carbohydrates. It is found that, depending on the age, the work, and other conditions, a definite proportion must be preserved between the proteid and the carbohydrate (fats and carbohydrates) factors in a ration, and this proportion is termed the nitrogenous ratio. The *nitrogenous ratio* needs to be highest in the young animal, for here proteid is wanted to allow of growth, and thus we find the ratio in milk is 1 : 3 (*i.e.* 1 of albuminoid to 3 of carbohydrate and fat taken together). In adult life and at fast work a horse requires a ratio of about 1 : 6, whereas at slow work or at rest the ratio falls to 1 : 9 or 1 : 12. In all cases the ratio should be calculated, not on the chemical composition of the food, but on the amount of each constituent digested by that particular species of animal. In selecting a suitable ration for any animal it is necessary, then, to fix in advance the suitable nitrogenous ratio for the kind of work the animal is required to do, and then to see that the total ration will supply digestible constituents in the necessary proportion.

There are important differences, structural and functional, between horses on the one hand, and cattle and sheep on the other. The latter, and in fact all ruminants, can digest fibrous coarse food containing cellulose much better than the horse, and so this class of food, straw, coarse hay, and grass, is much more nutritive in ruminants than in horses. At the same time, even in the horse a certain amount of fibre is necessary to supply bulk for the intestines to contract on, and it has been found that a food devoid of woody fibre, for example, maize, requires some fibrous material like straw chaff or timothy hay to be fed with it, or disastrous results follow. Very highly nitrogenous foods, such as beans and peas, can only be given with advantage in small quantities, about 1 lb. per diem being enough for horses. Larger quantities predispose to skin eruptions and grease. Excess of bran in a ration has often been held to explain the formation of intestinal calculi, and to cause certain bone diseases, the reason being that bran is rich in salts, especially phosphates. Then certain other foods are usually avoided in horses: wheat is not good, and if fed, often leads to digestive troubles; barley is credited with being dangerous, although it has been used on a large scale on different occasions with no ill effects. One condition must, however, be observed in all cases where the chief article in a ration is to be changed, and that is, that the change shall be very gradual.

In *a sick animal*, with fever, the diet should be light, easily digested, and laxative; but since the loss of nitrogenous tissue is very great, a diet rich in proteids may be necessary, when milk and eggs can be supplied. In an animal without fever, resting, say, for lameness, the diet must be restricted and the nitrogenous ratio low (1 : 12). Sick animals are often expected to live on bran mashes alone, but this is a great mistake. It is often of the highest importance to tempt an animal to eat, and variety in the food offered is essential. Steamed hay and hay tea are good; mashes of bran with a little maize meal or bean meal added, or with boiled linseed, are often taken when bran alone is refused; green fodder, such as rye, or clover, or tares, should be tried, or, often most appetizing of all, some fresh young grass. Then carrots are good, washed and cut longitudinally, or sliced mangels or swedes; and often horses can be tempted to feed by starting them with an apple or a piece of bread. For many conditions various gruels are good, such as linseed tea, and wheaten or oatmeal gruel; and milk, with or without the addition of eggs, is invaluable in an animal unwilling to take anything solid. The withholding of water for a short time will usually induce a horse to drink milk, and once tried there is usually no further difficulty. Finally may be mentioned such appetizers as malt and the various molasses-containing meals. To assist in putting on flesh when a horse is poor and emaciated, linseed alone and linseed and cotton cakes are very good; and in almost all cases it is well to supply a sick or debilitated

animal with some rock salt in the manger, and with a plentiful supply of water. The *water* supplied to farm animals is often very impure, and not infrequently a cause of disease. Too hard water causes a rough staring coat, may give rise to indigestion, and undoubtedly favours the formation of intestinal calculi. Water contaminated with sewage is bad for any animal, and especially if the sewage contain the discharges from other animals not infrequently themselves the subjects of contagious disease. Contaminated water supplies have been blamed, and not without reason, for some cases of contagious abortion, and in towns public drinking troughs have often been thought to transmit glanders from diseased to healthy horses. Most important of all is the water supply to milch cows and to a dairy farm; and it is interesting to note that one of the largest London dairy companies finds it necessary to refuse tenders for the supply of milk from nearly half the farms applying, solely because of impure water supplies. Milk-borne diseases such as typhoid are such serious dangers to human health that an absolutely pure water supply, for the cows to drink, for washing churns and utensils, and all the purposes for which water is used in a dairy, is imperative.

Exercise.—To maintain active health, exercise is a necessity, and although it is safely dispensed with in a fatting beast, the enforced idleness brings about such a debilitated condition of the heart and muscles, that only months of exercise and training would bring about recovery if an active life were again necessary. In a working animal such as the horse, inactivity and idleness in confinement are always dangerous to health. A *box* has this great advantage over a stall, that the inhabitant can get a certain limited amount of exercise in it, and so, if for no other reason, a box is usually to be preferred, whether in health or sickness. There are certain *diseases*, both of horses and cattle, for which want of exercise combined with liberal feeding, often with a full workaday diet, are in the largest measure responsible. In horses, 'filled legs', and an itchy, irritable condition of the skin with an eruption of pimples, are often simply due to want of exercise. Much worse are the attacks of *lymphangitis* (commonly known as 'big leg', 'Monday-morning disease', or 'weed') and the very serious condition known as *hæmoglobinuria*, causing paralysis of one or both hind limbs, together with the passage of dark-brown or black urine. Both these diseases are seen in horses rested for one or two days, whilst being at the same time liberally fed. Again, *milk fever* in cows is largely avoidable if susceptible animals are made to exercise, and are rather sparingly fed for a few weeks before calving. Then, too, in mares prior to foaling, filled legs and partial paralysis of the hind quarters are not uncommon, and these can be prevented by timely exercise. Exercise improves the appetite, stimulates digestion and the secretion of the digestive juices; it improves the circulation, and promotes action of the excretory organs, so getting rid of waste products of tissue activity. Whenever exercise for any reason becomes impossible, as in cases of lameness, the diet must be cut down accordingly, and some laxative, such as a small dose of Epsom salts, should be given occasionally.

Work, on the other hand, generally speaking, militates against digestion, so that a heavy feed just before hard work, or immediately after stopping work, is detrimental to health. Many cases of colic result solely from this cause, and especially in those cases where, after a long period at work without food, an animal is supplied with a large amount of food, and feeds greedily. The diet should always be arranged in relation to the particular work the animal is to do. Given a suitable ration, an adult horse should be worked without loss of condition or distress. As for a man, so for a horse, six days' work a week is as much as can be well done. *Overwork*, whether on account of excessive speed, too long distances, or too heavy loads, if continued, is sure to result in loss of condition, or lameness, or increased susceptibility to diseases such as colic, or lung troubles. Suitable work on a suitable diet, and with harness fitting, and grooming well carried out, will be evidenced by good or improving condition, general fitness, and good health.

Signs of Health and Disease.—An animal's state of health may be judged by the presence or absence of certain signs, and it is well that these should be reviewed in a definite and orderly manner. Especially is such a review valuable in the case of an epidemic disease, where susceptible but as yet healthy animals have to be inspected daily so that any affected ones may be at once detected. In a state of health, the *appetite* for food and water remains good; food is taken, masticated, and swallowed without difficulty; the animal takes its *rest* well, lies down at night, and is not uneasy. The *eye* is bright and clear, and the mucous membrane round it (conjunctiva) of the normal pink colour. The *coat* is smooth and glossy, the skin soft and supple, not hidebound with rough staring coat. The *bowels* are regular; urine is passed in normal quantity and appearance, and without straining. *Respiration* is normal in speed and depth, regular, the animal not 'blowing' or showing respiratory distress. The *pulse* is regular, of proper force and frequency, not irregular, or intermittent, or very frequent, or again much too slow. The pulse may be taken at any place where a medium-sized superficial artery runs over bone: in the horse, where the facial artery passes round in front of the angle of the jaw, or on the under surface of the tail on both sides of the middle line, the frequency in health being 36 to 42 beats per minute; in cattle, either at the facial artery over the jawbone, or from the metacarpal artery just behind the fetlock and between the two supernumerary digits, with a normal frequency of about 50 beats per minute. In the small animals—sheep, pigs, and dogs—the pulse is taken at the femoral artery, which runs down the middle of the inside of the thigh; but the pulse rate in these animals is of little value in detecting disease. Very important is the body *temperature*. In many diseases the severity of

the attack is proportional to the rise of temperature, and moreover this rise is frequently the first sign of infection during the course of an epidemic. Clinical thermometers on which the average normal temperatures of the various farm animals are marked, can be obtained from most instrument makers. These average healthy temperatures on the Fahrenheit scale are—horse, 100°; ox, 101·5°; sheep, 104°; pig, 102°; dog, 101·5°; fowl, 107°. The temperature is taken in each case by inserting the major part of the thermometer in the animal's rectum, leaving it *in situ* for from a half to two minutes, depending on the instrument. In the majority of cases a rise of 2 or more degrees above the normal temperature may be looked upon as serious, and will suggest that attention is needed. If the animal is sound, it will be able to walk and move about normally, there will be no groaning or grunting on lying down or getting up, and there will be an absence of abnormal swellings, or of undue heat, or of any of the signs of pain. *Pain* is so important a symptom of some abnormality that the signs which suggest pain must be detailed. An animal in pain is uneasy, often pawing the ground, or paddling with the hind feet; it won't eat, or sometimes eats savagely for a short time; there is often patchy, sometimes profuse, sweating. If the pain is in the thorax or abdomen, the animal often looks round at the flanks; lies down suddenly, in some cases violently, then rolls, and often suddenly rises again. There is groaning, grunting, and, in cattle, grinding of the teeth. In colic a marked feature is frequency of attempts to pass urine, although the urinary tract is usually quite healthy. There is a haggard, drawn expression on the face; and after a time the animal either becomes dangerously violent, or settles into a condition of stupor leading to unconsciousness.

In *cattle* a few special signs may be mentioned. In health there is dew on the nose; the animal, when at rest and not feeding, is seen to be quietly chewing its cud; the horns are cool; and in a milch cow the secretion of milk is normal. Early in any febrile disease the animal ceases to chew the cud, the horns are hot, nose dry, milk secretion lessened, and the temperature raised. The presence of cough as a marked symptom, especially if accompanied by a discharge from the nose, must be looked upon as serious in any animal.

In *sheep* it is especially necessary to be on the lookout for signs of the following conditions: *Footrot*, suggested by lameness; *sheep scab* or mange, shown by a tendency to rub against hurdles and posts, and for the wool to come out; attacks by *maggot* or *fly* in summer, when the wool about the hind quarters and tail is left long and dirty, shown by uneasiness and lameness; *hoose* or *husk*, an affection of sheep and lambs, with small threadworms in the windpipe and bronchial tubes, shown by a frequent husky coughing; and lastly, parasitic (worm) infection of the stomach and intestines, affecting chiefly lambs, occurring on damp, low-lying pastures, and shown by chronic, often fatal, diarrhœa.

The *pig* is in this country the subject of practically one contagious disease, namely *swine fever*, and this condition is indicated by cessation of appetite, a tendency for the pig to burrow down in the straw and lie there, squealing if disturbed, and then by diarrhœa. Often there are purple blotches or marks on the skin, a catchy cough, and hurried breathing.

The Prevention of Disease.—Certain steps are taken by the Board of Agriculture and Fisheries to lessen and to prevent contagious disease, and almost all these measures are provided for in the Contagious Diseases (Animals) Act of 1894 (see Diseases of Animals Acts). Firstly, the *importation of disease* from abroad is prevented by the prohibition of the landing of live cattle, sheep, and swine in this country, except from certain stated countries, such as Canada and the United States, and then only for slaughter at the port of entry within ten days of landing. This rule is a most valuable one, and is largely responsible for our immunity from many of the contagious diseases of animals. Within our own borders several *contagious diseases are notifiable* by the owner of an affected animal to the police, who in turn inform the veterinary inspector of the local sanitary authority. These scheduled diseases are—anthrax,* cattle plague, foot-and-mouth disease, glanders,* epizootic lymphangitis, mange in horses,* pleuro-pneumonia, rabies, sheep pox, sheep scab,* swine fever.* Of these, the majority are extinct in the United Kingdom at the present time; but those indicated thus (*) are still prevalent, and have to be looked out for. *Mange* of horses is notifiable in some districts but not in others. *Foot-and-mouth disease* has been introduced from time to time, probably in foreign hay and straw, from countries where the disease is prevalent, and the importation of hay and straw from such countries is prohibited by an Order issued by the Board of Agriculture. On being notified of the existence of any one of these diseases the veterinary inspector of the local authority or of the Board of Agriculture puts into force the Order of the Board dealing with that particular disease. In general outline[1] the procedure under most of the Orders is as follows: The building or farm is declared an 'infected place', and a suitable area round it is an 'infected area'; movement of any susceptible animal into, or out of, an infected place is prohibited, and movement of animals inside the infected area is only allowed by licence issued by the local authority; the affected or suspected animals are dealt with, in some cases by compulsory slaughter, in others by voluntary slaughter on the part of the owner, or by isolation of the affected, suspected, and all in-contact. Carcasses of diseased animals are disposed of by burial 6 ft. deep in quicklime, or by cremation; the premises are suitably disinfected, and all in-contacts are inspected until such time as they are thought to be without doubt free from contagious disease. Special measures are taken in connection with special diseases to prevent their spread, as in the case of *sheep scab*, where a com-

[1] For details of procedure in each case see under the name of the disease.

pulsory dipping order may be enforced; or in *anthrax*, where no post-mortem examination is allowed. In addition to these measures, markets and fairs in the infected area may be closed, and any animals found to be suffering from contagious disease whilst in a public place are in most cases removed to the nearest slaughter-house for slaughter, the in-contacts being detained in quarantine. But besides the notifiable diseases there are many others which are contagious, and here the stock-owner is left to his own resources in the matter of prevention. Among the more important *contagious diseases* may be mentioned pneumonia, strangles, and influenza, of the horse; and tuberculosis, abortion, cow pox, and some forms of mammitis, in cattle. *Tuberculosis* is discussed separately elsewhere, but for the rest it is advisable to briefly indicate the right line of action. We will assume an outbreak of disease, one or more animals having been found affected. The first step to take is to *isolate* the affected animal, providing separate utensils and a separate attendant. The history of the attack, its time of onset, the symptoms shown, and the temperature should be recorded for future reference. Then *emergency treatment*, or homely remedies, may be tried; and here it may be mentioned that remedies of known composition, supplied by a reputable veterinary surgeon or chemist for a specific purpose or disease, are much better and safer than the unknown but highly vaunted remedies which are advertised to cure diseases many and various. Most professional men are prepared to supply horse and cattle medicines for home treatment and for emergency use; and when at a later stage the veterinary practitioner is called in, he knows what the animal has already had, and can adapt his further treatment accordingly. If professional advice is needed it should be called for before too much has been done to the animal, and before an epidemic has got a good hold. An intelligent account of the history and onset of the disease, with a description of the symptoms noticed, will greatly help the veterinary surgeon, and early isolation will in many cases have prevented further spread. Where an animal has died, unless the cause of death is well known, an explanation should certainly be sought by means of a *post-mortem* examination. If *anthrax* is suspected, opening of the body is illegal, and is dangerous to the person doing it, and only a bacteriological examination will decide the question. In any other case a post-mortem examination is valuable, and many obscure cases of poisoning or of preventible disease are only discoverable by this means.

Of *preventible diseases* there are many, and it is necessary to mention the commoner ones. Among young animals of any species *rickets* is fairly common, and it is due to some weakness or debility of the dam, or to want of fresh air, sunlight, exercise, or proper nourishment of the young and growing animals. Among horses, *acute lymphangitis* and *hæmoglobinuria* have both been mentioned as being due to the combination of two or three days' rest and liberal work-aday feeding. In cows, *milk fever* results from a similar set of circumstances occurring at or about the time of calving, and the judicious use of purgatives, together with suitable feeding and exercise, will prevent most cases.

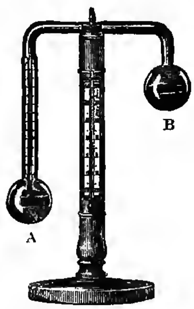
Redwater or *muir-ill*, a disease of cattle seen in Scotland and the west of England, is due to an animal parasite in the blood, this parasite being introduced by the bites of ticks. The destruction of the ticks by dipping the cattle, or by burning off rough coarse herbage and grasses which harbour the ticks, or again the tillage and cultivation of rough land, all go to prevent this disease. *Louping-ill*, affecting sheep, is similarly caused and similarly prevented. *Black-quarter*, a disease of cattle and sheep, is a specific disease got from infected fields and pastures, and it can be prevented by means of a *vaccination* process which is both scientific and reliable—terms which cannot be applied to the old-fashioned procedure of setoning and drenching. Lastly may be mentioned *tetanus* or *lockjaw*, a disease which commonly affects horses, cattle, and sheep. This is due to a bacillus which is found in the soil in many localities, some districts being almost immune, whilst others are badly infected. In the majority of cases the infection takes place through a wound—often after castration and docking—and the use of disinfectants, and the cleanliness of wounds and the surroundings of the animals, are useful measures of prevention. Prior to an operation on a valuable animal, such as castration of a valuable horse, in a district where tetanus is prevalent, an injection of *anti-tetanic serum* may be made, and this will procure the animal's immunity from tetanus until the operation wounds are healed.

Disinfection of a building after contagious disease is important, and it must be thoroughly carried out. Firstly, all litter, dung, soiled fodder, and such like should be taken out and burned as near the building as possible, without allowing them to spread contagion on the ground. All movable fittings and furniture should be removed for disinfection outside the building. The floor, if of brick or stone, should be scraped, and then well washed with a disinfectant solution; if of soil, the top layer to a depth of 2 or 3 in. should be removed. The walls and roof or ceiling should be brushed or scraped; the woodwork and paintwork scorched with a painter's lamp and then scraped; the manger or trough scoured out with boiling water, and then with a disinfectant, or an old wooden manger should be taken out and burned. Next, the scrapings may be burned inside the building, or outside as near to it as possible; all windows and doors should be closed up and made as far as possible air-tight, and the building fumigated. The best agents for this purpose are sulphur dioxide vapour, got by burning sulphur (1 lb. per 1000 cu. ft.), or formaldehyde vapour, by heating paraform tablets. After fumigation the building is left for a suitable time (24–48 hours), then doors and windows are thrown open so that fresh air and sunlight may perform their beneficial work. Lastly, the walls should be limewashed, the wash containing 5 per cent of carbolic acid; the wood and metal work

repainted; and the building is ready for occupation by healthy animals.

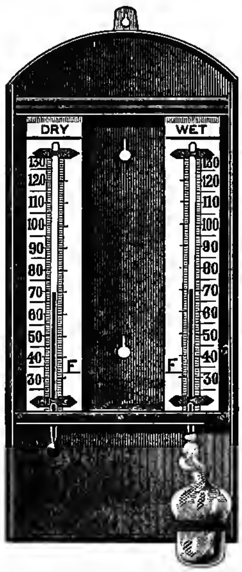
Diseases of Animals Transmissible to Man.—The more important ones are: *Anthrax*—got from inhalation or ingestion of anthrax spores from fleeces or hair of animals dead of anthrax ('wool-sorter's disease'), or from spores or bacilli introduced into skin wounds of men engaged in handling fleeces or hair, or in dressing a butcher's carcass where the animal has been suffering from anthrax; *Glanders*—got from nasal discharge, or pus from an abscess, in a horse affected with glanders; *Tuberculosis*—from milk the produce of a cow suffering from tuberculosis, or, in the case of a butcher, from dressing the carcass of such an animal and getting infected by reason of a cut on the hand. *Rabies*, or *hydrophobia*, usually results from the bite of a dog affected with the disease. *Foot-and-mouth disease* has affected a few persons drinking the milk of affected cows. *Cow pox*, or *vaccinia*, may be got by milking a cow suffering from the disease. *Actinomycosis* affects both cattle and the human subject, but there is no good evidence of transmissibility from the one to the other. Milk may sometimes convey the infection of *scarlet fever* or of *diphtheria*, but the cow does not suffer from these diseases, and the contagion is certainly traceable to a human source. There are a number of parasitic diseases of animals which may affect man to some extent, namely, *mange* of horses, and *ringworm* of cattle, dogs, and cats. Man may be infected with tapeworms of the intestine from eating diseased ('measly') beef (*Tænia mediocanellata*), and from 'measly' pork (*T. solium*); or with the muscle worm (*Trichina spiralis*) from affected pork; or with hydatid cysts (*Echinococcus veterinorum*) in the liver, or other tissues, from the ingestion of eggs from a tapeworm infesting dogs. For the prevention of infection, and for the eradication of these conditions, each disease must be referred to specially. [H. A. W.]

Hygrometer is an instrument for determining the dew-point of the atmosphere. The dew-point is the temperature at which the atmosphere begins to deposit water vapour. There are several kinds of hygrometers in use, the principal being: (1) Daniell's, (2) Regnault's, (3) Mason's, (4) Dines's. All of them assume somewhat different forms, but the principle of their action is much the same in each. It depends upon the fact that when the atmosphere is cooled down to the temperature at which it is saturated, moisture will at once begin to deposit, and this point is observed by the dimness of a bright surface of metal from the deposit upon it of water vapour. The temperature is at the same time taken, and these and other observations supply all the necessary facts.



Daniell's Hygrometer

Daniell's hygrometer consists of a cryophorus containing ether in place of water. One of the globes, A, of the cryophorus is made of black glass or has a gilded zone round it, and contains a thermometer. The other globe, B, is of ordinary plain glass. The tube and the attached bulbs are fixed on a stand, to which is attached a thermometer for indicating the temperature of the atmosphere. To use the instrument, all the ether is passed into the globe A, and muslin is placed round the globe B. Ether is then poured over the muslin, and as it evaporates absorbs heat. This soon causes the ether to evaporate also from A, thus lowering the temperature of the bulb, indicated by the thermometer. The lowered temperature causes a dulling of the surface of the gilded part by the deposition of water vapour upon it from the atmosphere. The temperature at which the dulling occurs is carefully noted, together with the temperature at which the dullness afterwards disappears.



Mason's Hygrometer

The average of the two readings is taken as the dew-point.

Regnault's hygrometer is really an improved form of Daniell's hygrometer. It consists of a glass tube closed at the base in a silver cup. The mouth of the tube is fitted with a cork carrying a thermometer and a piece of glass tubing, both passing down to near the bottom of the tube. Ether or alcohol is placed in the tube and a current of air drawn through by an aspirator. The air causes the liquid to evaporate, the temperature falls, and ultimately moisture from the atmosphere dulls the silver. The temperature at which this occurs is noted, and again also when the dullness disappears. The average of the two readings is taken as the dew-point. This hygrometer has several advantages over Daniell's, in that the rate of cooling is more easily regulated, and the observations more accurately taken.

Mason's—wet and dry bulb thermometer—consists of two exactly similar thermometers, mounted on the same stand in such a way that air can freely circulate round the bulbs. One of these gives the air temperature; the other has muslin wrapped round the bulb, which is kept moist by means of an attached wick communicating with a vessel of water. The evaporation of water from the wet bulb causes a fall of temperature, and consequently the wet bulb always reads lower than the dry one, unless the atmosphere is saturated with water vapour, when the two would read alike.

The difference between the readings of the two thermometers is noted. This difference corresponds to a certain humidity of the atmosphere, which has been determined by other methods, and shown on a printed table supplied with the hygrometer.

Dines's hygrometer is also a simple and convenient form of instrument, working upon the same principle as those already described; but this form is not in such general use.

The humidity of the atmosphere is an important factor in the making of weather forecasts. [R. A. B.]

Hylemyia coarctata (the Wheat-bulb Fly) is a pest generally present to some extent in wheat crops, and sometimes seriously injurious. The insect is a grey fly, nearly the size of the common house fly, and lays its eggs in March near the roots of the wheat plants. The maggots eat into the heart of the plant, where they feed throughout April, attaining nearly $\frac{1}{3}$ in. in length. In May they burrow into the ground to turn to pupæ. Little is known of their after-history, but there are probably subsequent broods on wild grasses. Failure of the young wheat crop in April or May, with discoloration just above the root, where whitish maggots may be found, is attributable to this pest.

Treatment.—Wheat after fallow suffers most, though the reason for this is not known. No satisfactory preventive measures have been discovered, but thick seeding is advisable where attack is anticipated. [C. W.]

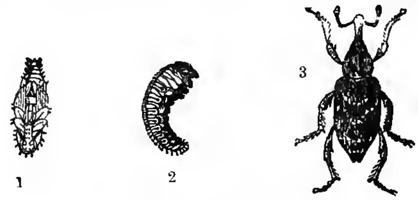
Hylesinus, a genus of bark beetles which attack the bark of various deciduous trees.

H. fraxini (the Ash-bark Beetle) is about $\frac{1}{8}$ in. in length, and lays its eggs in the branches and trunks of ash trees, whether healthy or failing, in April or May. It bores a characteristic forked gallery, along which the eggs are laid, and the grubs, which hatch out in May, form tunnels in the bast at right angles to the mother gallery. In August they have developed into mature insects, and leave the bark by numerous 'shot holes'. *H. vittatus* is somewhat smaller, and attacks the elm. *H. crenatus* is nearly $\frac{1}{4}$ in. in length. It attacks the ash, generally selecting the larger trees. There are two annual attacks, in April and October.

Treatment.—(1) General attention to the health of the trees. (2) Tarring slightly infested trees. (3) Barking badly attacked trees in July, and burning the bark before the beetles emerge. [C. W.]

Hylobius abietis (the Pine Weevil) does great injury to young coniferous plants, especially Scotch pine and spruce, by gnawing the bark. Weakly trees from three to six years old suffer most; bark which is more than six years old is too hard for the weevil to attack. Young plants may be entirely girdled or even peeled by the weevils, but attacked stems normally show beanlike patches where the bark has been gnawed away and resin exudes. The weevil, which is about $\frac{1}{2}$ in. long, dark-brown with golden linear markings on the wing covers, and a stout curved rostrum or 'beak', appears in May, and continues to lay eggs throughout the summer in the stumps and roots of felled Scotch pine and spruce. The grubs, therefore, are harmless, and the weevils alone attack sound trees. They are often very numerous in felling areas.

Treatment.—Felling areas should be small, and not adjoining till after a lapse of three or four years. Stumps should be removed before the winter following the felling. Autumn-planted



Pine Weevil (*Hylobius abietis*)

1, Pupa. 2, Larva. 3, Perfect insect.

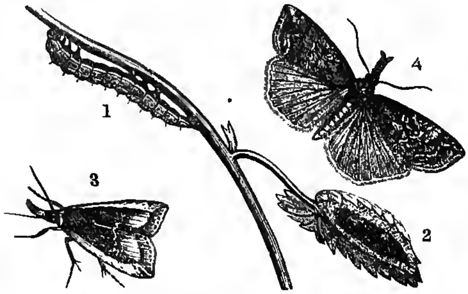
trees suffer less than those planted in spring. Other useful measures are the feeding of sheep over the felling areas, and the admixture of broad-leaved trees with the conifers. [C. W.]

Hylurgus (Myelophilus) piniperda (the Pine Beetle) attacks varieties of pine trees, and is occasionally found on the spruce, and very rarely on the larch. Old trees are preferred, and the pest seldom occurs in plantations less than ten years of age. The injury is twofold, the beetle first attacking the bark, while the brood reared therein proceed to burrow into the extremities of the shoots, often quite altering the shape of the tree. A third kind of injury is sometimes observed, the beetles boring into the rootstocks to hibernate. The beetles, which are about $\frac{1}{6}$ in. long, appear in March and April, and lay eggs in the trunks, preferring dying trees or felled timber for the purpose. The eggs hatch in about a fortnight, and the grubs burrow in the bark, being fully fed about the end of June. The beetles which emerge in July produce a second brood in the bark, and the beetles which emerge at the end of August attack the shoots, entering them about 3 in. from their extremity and working towards the buds. No excrement is to be found in their tunnels, which otherwise resemble those of the Pine-shoot Tortrix (see RETINIA).

Treatment.—(1) The uprooting, or at all events the barking, of pine stumps. (2) The removal of sickly trees. (3) Where the pest is present, all valuable thick-barked timber should be removed before the beetle emerges. [C. W.]

Hypena rostralis, Linn. (the Hop-vine Snout Moth).—The caterpillar feeds upon the leaves of the hop, nettle, and birch. It has only fourteen feet, is green, with a very fine brown dorsal line, and a white one down each side, with scattered black warts, producing short hairs (fig. 1). The slender brown chrysalis is contained in a grey transparent web (fig. 2), spun amongst the leaves by the caterpillar. There are two broods of the moth—one as early as the middle of April, the other in June or July. The insect rests upon walls and palings round gardens, with its wings forming a triangle (fig. 3);

the antennæ are very slender, and the mouth-parts snoutlike; the upper wings are brown and variegated, the under wings smoky (fig. 4.) To



Hop-vine Snout Moth (*Hypena rostralis*)

1, Caterpillar; 2, chrysalis; 3, moth at rest; 4, moth with wings expanded.

destroy the larvæ, syringe the hops with strong soapsuds. [J. C.] [C. W.]

Hypericum, the botanical name for St. John's Wort, a genus of perennial dicotyledonous plants belonging to the nat. ord. Hypericaceæ, marked by opposite, sessile, entire, ribbed leaves, which when held up to the light show clear dots; by yellow petals with oblique veins, not grown together; by indefinite stamens (due to branching), and by carpels imperfectly grown together so that the styles remain distinct. The superior fruit is composed of a dry seedcase, which opens by valves to allow the numerous minute sausage-shaped seeds to escape. These plants contain a poisonous, resinous yellow juice akin to the well-known gamboge. They are not readily eaten by stock; still, cases are on record where horses supplied with lucerne hay containing St. John's Wort died from the poisonous effects.

The important weeds are:—

1. Perforated St. John's Wort (*Hypericum perforatum*), a bald perennial herb frequently found in moist meadows and pastures, also in copses and on hedge banks. The erect stem is cylindrical, with two edges, and rises to a height of 1 or 2 ft. The oblong leaves, about 1 in. in length, have blunt points, and when viewed by transmitted light show numerous clear dots. At the end of the stem is a corymb of yellow flowers, each about 1 in. in diameter.

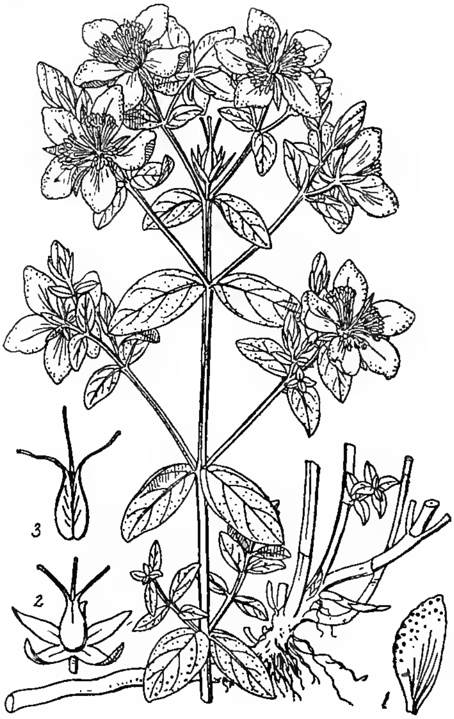
2. Square-stalked St. John's Wort (*Hypericum quadrangulum*), another perennial weed of moist pastures, distinguished from the preceding species by the stem being square, with four ridges instead of two.

3. Small Upright St. John's Wort (*Hypericum pulchrum*), a perennial weed of heaths and dry ground. It is distinguished by the cylindrical stem without ridges, by the broad, glossy, heart-shaped leaf about ½ in. long, by the tinge of red on the yellow flowers, and by the red anthers of the stamens.

4. Marsh St. John's Wort (*Hypericum elodes*) occurs on wet moors and in spongy bogs. This is a woolly plant, with low creeping stems about 8 in. high, and leaves about ½ in. long and nearly as broad.

5. Large-flowered St. John's Wort (*Hypericum calycinum*) is a well-known plant useful for sheltering game, often cultivated in shrubberies and on rockeries. This is a woody species, creeping extensively, which bears bright-yellow flowers about 3 in. in diameter. [A. N. M'A.]

The common Hypericums generally cultivated are the large-flowered, hardy species, and some of these have the particular virtue of forming a dense carpet under the partial shade of trees, and when in flower in summer they present a most attractive spectacle. They will thrive in any ordinary soil, and may be planted in game coverts, sandy loam suiting them best. They



Perforated St. John's Wort (*Hypericum perforatum*)

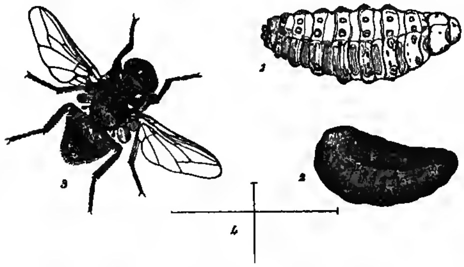
1, Petal. 2, Pistil. 3, Fruit.

are easily propagated by cuttings or division. The most ornamental kinds are: *H. Androsæmum*; *H. calycinum*, the best for carpeting; *H. Hookerianum*; *H. moserianum*, a garden hybrid; and *H. patulum* and its var. *Henryi*. [W. W.]

Hypertrophy. — Undue or excessive development of an organ or structure in an animal is called hypertrophy, and is the opposite condition to atrophy. Excessive use is a cause of hypertrophy, just as disuse is a cause of atrophy; hence we find that where one kidney has been extirpated, the remaining one enlarges and carries on the work of two. It is then described as hypertrophied. The occlusion of a jugular vein following on inflammation from bleeding with an unclean instrument, induces

greater flow in the other. Excessive exertion dilates the heart and gives rise to one of two forms of hypertrophy, in which the walls may be thickened without alteration in the cavity, or both may be increased. Hypertrophy is more often compensatory than to be regarded as a diseased condition. [H. L.]

Hypoderma, a genus of bot flies which includes the flies which cause 'warbles' in



Hypoderma lineata (the English Warble Fly)

1, Fully grown warble grub; 2, pupa; 3, the fly, slightly enlarged; 4, its natural size.

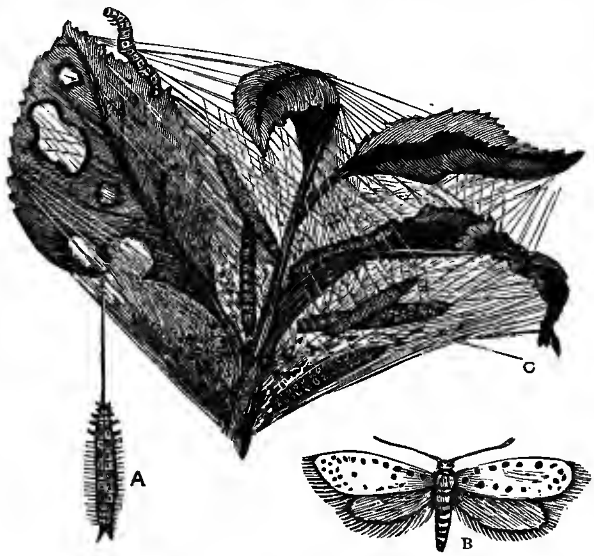
cattle. There are two species prevalent in the British Isles. The common English warble fly, though generally known as *H. bovis*, is in reality *H. lineata*, while *H. bovis* is the species usually met with in Ireland. Warble disease is too familiar to require minute description. Affected cattle suffer from more or less numerous abscesses, situated mostly along the back, and each abscess contains a warble grub, which lives on the purulent matter of the abscess, and maintains a communication with the outer air by a small hole in the warble. Though much attention has been directed to this pest, there are still obscure passages in its life-history. It was formerly thought that the fly laid its eggs on the animals' backs, and that the grub which hatched out immediately bored its way under the skin. It has been definitely proved, however, that the great majority of the eggs are laid on the legs, and there are many facts which indicate that the grubs, sometimes at least, reach the skin by way of the gullet, being licked off by the animal in the same way as the horse bot (see GASTROPHILUS EQUI). The following facts, however, are established. The flies are about in July, August, and part of September, and lay their eggs on cattle, choosing especially the neighbourhood of the hock or the region behind the shoulder. Yearlings, particularly heifers, especially suffer. Though the fly is incapable of stinging or biting, its presence causes great excitement in the herd.

By whatever route, the grubs eventually establish themselves beneath the skin, where they remain at least till the following May, by which time they have attained fully 1 in. in length. In May or June the fully fed grubs wriggle their way out of the warbles and fall to the ground, where they turn to pupæ, from which the flies emerge about seven weeks later. Apart from the pain inflicted on the cattle, the loss to the farmer is extremely serious. The animals lose condition, the flesh may be rendered partially unfit for food ('licked beef'), and the hides are rendered nearly valueless.

Prevention. — The dressing of the animals' backs during the summer with some ill-smelling preparation which shall keep off the fly has been largely practised and advocated. Paraffin emulsion (churn up 2 gal. paraffin and ½ lb. soft soap with 1 gal. hot water, and dilute with eight times its bulk of water) is a favourite dressing. Recent experiments have, however, thrown great doubt on the efficacy of any preventive washes. It is important that cattle should be allowed access to shelter and to water during the fly season.

Remedy.—By far the best method is to squeeze out the warble grubs in the spring; but various smears are used to kill them in the warbles—tar, cart grease, and sulphur, or M'Dougall's smear, being more or less effective. By their application to the warble openings the grubs are deprived of air, and perish. [C. W.]

Hyponomeuta, or as it is also spelt **Yponomeuta,** is a genus of moths of a bright silvery-white colour with black dots arranged in lines; sometimes called ermine moths. Members of the genus are to be found all over the world



Small Ermine Moth (*Hyponomeuta Padellus*)

A, Caterpillar. B, Moth. C, Larvæ in web.

except New Zealand, from which country there has not been any record. Six species are natives of Britain; *H. euonymellus*, L., and *Padellus*, L., are the most commonly met with. The larvæ or caterpillars are gregarious, feeding upon *Prunus Padus*, hawthorn, apple, blackthorn, &c. They

spin a fine gauzy web, sometimes 2 or 3 yd. in area, under which they will strip off all the leaves. When full grown, they change to pupæ in the web. From the fact of their spinning a large web, the popular name of 'tent caterpillar' is given to them. As for remedies, the Board of Agriculture give the following for the larvæ: 'If water under high pressure from a hose can be applied, the colonies may be effectively destroyed'. 'Hand-picking and cutting off infested twigs, and crushing the webs so as to kill the contained brood.' 'Spraying with paraffin emulsion'; 'the earlier this is done the better, so that the webs may not be so numerous or so thick, as they are difficult to penetrate.'

[J. J. F. X. K.]

Hypothec.—In Scots law a hypothec is a right in security over goods which are allowed to remain in the possession of the debtor, thus differing from pledge, where the goods held in security are placed in the custody of the creditor. In the form in which it is most familiar it is conferred on the landlord of premises let, in order to secure the payment of the stipulated rent, and it is in this sense alone that the right is here dealt with. The right needs no agreement to confer it; it is tacitly a part of every *bona-fide* contract of lease, and formerly applied to all subjects let. But by the Hypothec Abolition (Scotland) Act, 1880, it was provided that: 'From and after the 11th day of November, 1881, hereinafter called the commencement of this Act, the landlord's right of hypothec for the rent of land, including the rent of any buildings thereon, exceeding two acres in extent let for agriculture or pasture, shall cease and determine; provided that nothing herein contained shall apply to any claim for rent due or which may hereafter become due under any lease, writing, or bargain current at the date of the commencement of this Act'. This practically means that the landlord of any farm of over two acres in extent has no right of hypothec, and it is no bar to the operation of the Act that the rent paid is partly applicable to the buildings on the farm, provided the whole subjects are let as one. But where a dwelling house and byre were let, along with adjoining pasture fields, in one deed, but at distinct rents, it was held that the house and byre were let separately from the lands, that the Hypothec Abolition Act did not apply, and that consequently the landlord had a right of hypothec for the rent of the house, &c., over, *inter alia*, cattle in the byre. Nursery and market gardens, however, would not, it is thought, fall under the definitions of land 'let for agriculture or pasture', and as regards such subjects the landlord's hypothec is not affected by the Act.

The landlord's hypothec still subsists in all urban tenements, *i.e.* dwelling houses, shops, mills, factories, warehouses, and 'buildings generally which are not merely accessories to more important holdings'. It extends over all moveable property in the house, &c., belonging to the tenant. But property belonging to children, guests, lodgers, or servants is not, as a general rule, subject to the landlord's hypothec. If, however, a lodger brings in a material part of the whole furnishing, it may be a question, depending on the circumstances of the case, whether he is not really a sub-tenant of part of the premises. In such a case the rule is, that where a sub-lease is excluded by the terms of the contract, as is usual, and has not received the landlord's sanction, the sub-tenant's property is subject to the landlord's hypothec; and this, it is thought, is true to the extent that the sub-tenant of only a part of the subjects let 'has his effects hypothecated for the whole of the principal tenant's rent', and not merely to the extent of the rents due for the premises subleased. (Smith Premier Typewriter Co. *v.* Collin, 14 S. L. T. 764.)

There is a general presumption from possession of moveables that they belong to the possessor, but the contrary may be proved. Questions may thus arise as to the liability to hypothec of goods in a house not belonging to the tenant, and such questions usually arise with regard to articles either lent gratuitously or let on hire. There does not seem any difference in principle between the two cases, for the fact that consideration has or has not been given for the use of the articles does not affect the question. Where the whole or a material part of the furnishing of the house is lent or hired it will without question fall under the hypothec, since the landlord is entitled to assume that it belongs to the tenant, there being an obligation on a tenant to furnish the premises to an extent sufficient to secure the landlord in the rent, an obligation which will be enforced by the Court under pain of summary ejectment on default. Moreover, recent decisions have established the general rule that even single articles of furniture, including such articles as are in use to be hired, *e.g.* sewing machines, pianos, &c., are subject to the landlord's hypothec. But doubts have been expressed whether it would extend to articles hired for a temporary purpose, *e.g.* forms hired for an evening party or china for a dinner party. Moreover, the landlord will not be entitled to rely on the security of articles hired, if he has received definite intimation at the time when the goods are put into the house that they do not belong to the tenant.

The hypothec gives security for each year's rent successively, and if not made effectual within three months after the expiry of the year, ceases as regards the past year's rent. If the subjects of hypothec are removed from the premises let, the landlord is entitled to a warrant to carry back the goods. The hypothec is made effectual by sequestration for rent, followed by warrant to sell sufficient of the articles inventoried to cover rent and expenses.

Hypothec is postponed in competition with Crown debts, servants' wages, and the tenant's deathbed and funeral expenses. [D. B.]

Hysteria.—Hysteria in animals is not of very common occurrence, and takes the form of muscular contractions of the neck, with throwing back of the head in an upward direction. It is associated with the first period of œstrum, when a mare may be excited and disposed to kick, and otherwise get out of control. It comes

on quite suddenly, and if in harness, renders the animal dangerous. With dilated nostrils and watchful eyes, the patient is hypersensitive to the touch; but the symptoms usually pass off quickly, and do not necessarily recur at subsequent periods of œstrum. Heifers, whose temperaments are usually so much more lymphatic than those of mares, display even more excitement, and bellow loudly, champ their jaws and foam at the mouth, grind the teeth, and fall down as it were in fits. If bleeding from the jugular vein is promptly resorted to, an immediate cure results. Failing to perform this operation, we may get the desired effect from a bold purgative, as an aloetic ball for a filly, and aloes and salts in solution for a heifer. [H. L.]

I

Iberis, a genus of Cruciferæ, popularly known as Candytufts. About twenty species are known, most of them inhabiting the Mediterranean region. They are either annuals or perennials of easy cultivation, which flower freely and are ornamental. The best perennial species are *I. gibraltarica*, white, 1 ft. high; *I. saxatilis*, white, trailing, a good rockery plant; *I. sempervirens*, the common Candytuft, a native of Candia, and one of the most useful of hardy spring-flowering herbaceous plants; *I. Tenoreana*, flowers changing from white to red. The best annual species are *I. amara*, white or purplish; *I. umbellata*, white, lilac, or crimson; and *I. odorata*. The seeds should be sown in the open in fine soil in a sunny position in February. [W. W.]

Grecian Ibex (*Capra ægagrus*)

Ibex.—Strictly speaking, perhaps the term Ibex should be limited in its application to the wild goat of the Alps, called Steinbock by the Germans, Bouquetin by the French, and scientifically known as *Capra ibex*. But common practice hardly sanctions such a restricted use of the name, for it has been given to numerous species of wild goats occurring in widely separated localities. The true ibexes, sometimes regarded as a sub-genus of *Capra* (goats) under the name *Ibex*, are characterized by the possession of large scimitar-shaped horns which curve boldly backwards over the back, and are studded along their outer curve with large transversely set ridges or bosses, the anterior edge of the horn being broad and uncompressed. The Common or Alpine Ibex (*Capra* (*Ibex*) *ibex*) was formerly widely distributed at high altitudes in the Alps, but is now only found in some of the valleys to the south of Monte Rosa, where it is strictly protected. A large male stands about 40 in. at the shoulder, and the horns range from about 26 to 40 in. along their outer curve. Closely allied to it is the so-called Siberian Ibex (*Capra* (*Ibex*) *sibirica*), which ranges from the Western Himalayas to the Altai Mountains. It is a rather larger animal than the Alpine species, has longer horns, commonly exceeding 50 in. in length, and a much longer beard in the males. It is represented by numerous sub-species or local races characteristic of particular mountain systems. A third species is represented by the Nubian Ibex (*Capra* (*Ibex*) *nubiana*), which differs from the last two in having the horns considerably narrower in front and the ridges shorter in proportion. It occurs in the mountains of Egypt, Sinai, and Arabia, and is represented in Abyssinia by an allied form, the Abyssinian Ibex (*Capra* (*Ibex*) *walie*), which has stouter horns and is more massively built. In the form of its horns the Nubian Ibex approaches the true goats, in which these appendages have a bold scimitar-like curvature, but are compressed and keeled along the front edge, and have no distinct and large ridges. This type of horn is found not only in domestic goats, but also in their wild prototype the Persian and Grecian Ibex (*Capra ægagrus*), which extends from Sind, Baluchistan, and the Caucasus to the islands of the Ægean Sea. This animal stands about 37 in. at the shoulders, and the horns range in length from about 40 to over 50 in. Considerably smaller than the last, and standing only about 30 in. high, with horns measuring along

the outer curve only from 20 to 30 in., the Spanish Ibex (*Capra pyrenaica*), although resembling the Grecian Ibex in the black-and-white coloration of the legs, differs from all the species hitherto mentioned in that the horns are twisted in an open spiral with the point turned outwards. In the Caucasus, in addition to *C. ægagrus*, occur two forms of Ibex which have the lower portions of the legs black. They are locally known as Tur. The West Caucasian form (*Capra caucasica*) has horns which approximate in type to those of the Alpine Ibex; while in the East Caucasian form (*Capra cylindricornis*) they closely resemble those of the Bharal or Himalayan Blue Sheep. The term Ibex is also commonly applied by English sportsmen to a species of wild goat (*Hemitragus hylocrius*) found in the Nilgiri Hills, which is closely allied to the Tahr. The females of all ibexes are much smaller than the males, and carry shorter and lighter horns. Ibexes live only amongst rocks at high altitudes, and the different species do not appear to differ greatly from one another in habits. [R. I. P.]

Ice.—On account of its varied uses, ice has now become an important article of commerce, and its artificial manufacture an industry of growing dimensions. Large quantities of the natural ice produced in the winter months are stored in ice-houses mostly for private use. The total quantity stored in this way, however, only amounts to a small fraction of what is consumed for commercial purposes, hence a short description of the process involved in the artificial production of ice will be of interest.

The principle underlying any method of artificially manufacturing ice depends upon some means of mechanically producing 'cold'. A physical property of gases and liquids is brought into practical utility for the purpose. The particular property made use of is the one relating to the absorption or evolution of heat that accompanies the transformation of liquids into gases, or conversely. Matter of any kind, whether solid, liquid, or gaseous, either absorbs or parts with energy in the form of heat when undergoing changes in physical state; likewise it may be said that the particular state in which any kind of matter is existing is determined by the amount of energy it holds: gases contain most, liquids next, and solids least. This energy is called latent, and is removed in the form of heat when gases are converted into liquids and liquids to solids, and conversely it is taken up when solids pass into liquids and liquids into gases. This property of absorbing heat from other substances by liquids when passing into gases is made use of in the manufacture of ice. Gases at the ordinary temperature and pressure are more stable under such conditions than in any other, which fact accounts for their existence in that state. They are, however, converted into liquids by subjection to great pressure and low temperatures, but they soon pass back to gases when the conditions become normal again.

The refrigerating medium used in the artificial production of ice is generally anhydrous ammonia—that is, ammonia gas—or carbonic anhydride, both of which gases are condensable into liquids when subjected to a great pressure. In the case of ammonia a pressure of 150 lb. per sq. in., and of carbonic anhydride of 700 lb. per sq. in., is necessary for the condensation of the gases. The liquid can be kept at the ordinary temperature. If the pressure be removed, the ammonia liquid will at once commence to vaporize, and in so doing will take up latent heat from any body in contact with it, producing a low temperature. This can be easily shown by taking a small flask partly filled with liquid ammonia, and with its neck open to the atmosphere. The ammonia will vaporize rapidly, and if a thermometer be placed in the evaporating liquid its temperature will indicate a point much below zero. As anhydrous liquid ammonia is difficult to obtain, the experiment can be shown more conveniently by blowing air through ether contained in a flask. This causes the ether to evaporate, cooling down the flask, on the outside of which a covering of hoar frost, by the freezing of the moisture in the atmosphere, will soon be seen.

The machinery used in the manufacture of ice, with ammonia as the refrigerating medium, consists of the three following essential parts: (1) The gas compressor, by which the vaporized ammonia, cold and under low pressure, is compressed and discharged, comparatively hot and under high pressure, into the gas condenser. (2) The gas condenser, which consists of a number of coiled tubes through which the ammonia passes, and round which condensing water is circulated. Under the cooling action of the water the warm ammonia gas is cooled and condensed to liquid form, and is passed from the condenser into the evaporator. (3) The evaporator, where, under reduced pressure, the ammonia liquid vaporizes, producing any degree of cold desired. After vaporizing it passes on to the gas compressor, and thence again to the condenser. The cycle is thus a completely closed one, having three stages, namely compression, condensation, and re-evaporation. The evaporator is generally similar in construction to the condenser, except that the coils are surrounded by brine, which has to be cooled. Between the condenser and the evaporator is the regulating valve, which regulates the pressure and amount of ammonia liquid which is passed into the evaporator, and controls the temperature.

The ammonia acts as a conveyer of heat, extracting it from the brine in the evaporator, which is thereby cooled, and delivering it to the water flowing through the condenser, which is thereby correspondingly heated. The brine cooled in the evaporator is pumped on to another portion of the plant, namely the ice tank. This ice tank is rectangular in form, and contains the small cans which are filled with the water to be frozen. The brine, in passing over the outside surface of these cans, extracts heat from the water within the cans, ultimately freezing it. After the ice is formed in the cans, each can is placed for a few moments into a bath of warm water, which loosens the ice in the can, and it can be then emptied out and the can refilled for

making a further quantity of ice. Refrigerating machinery is introduced into all modern liners, and ice rooms form an essential part of all cargo vessels containing meat and other perishable goods. Ice is an indispensable adjunct to the dairy industries. See art. REFRIGERATION.

[R. A. B.]

Ice—Damage to Woodlands.—Ice in woodlands, of course, causes most damage among evergreen conifers, and especially to long-leaved trees or crops of pine. The damage is usually greatest on northern and eastern hillsides, when cold north and east winds cause masses of ice to weigh down the branches and twigs. And if a heavy snowstorm should come on while branches are thickly coated with ice or hoar frost, then much damage may be done. Owing to the brittleness of its branches, the Scots Pine is the tree least able to withstand the heavy pressure of ice or snow; while among broad-leaved trees alders are most liable to injury, then young oak standards in copses if they have much dead foliage adhering to their branches. In conifer woods the most dangerous age is from about thirty to fifty years, just when the trees begin to expand laterally; though naturally the trees growing along the edge of roads or rides, and isolated trees in copses and parks, are more likely to be damaged than trees growing in the interior of the woods. Prevention is impossible, and the best remedy is to remove damaged timber as quickly as it can be extracted and disposed of.

[J. N.]

Ice Age. See GLACIAL EPOCH.

Iceland, Agriculture of.—The island of Iceland, lying just outside the Arctic Circle, is a Danish possession having an area of about 40,000 sq. miles, or a third more than Scotland. The coast, especially towards the north and west, is indented by a large number of fjords, which abound with fish. The interior of the island is one vast plateau, from which volcanic mountains raise their heads, only a few being active volcanoes. Enormous masses of snow and ice (including great glaciers) cover the mountains of the interior, from which broad and milky rivers arise and force their way to the coast. One would imagine that with such a rigorous climate agricultural pursuits would be necessarily limited; yet recent statistics show that 57 per cent of the 80,000 inhabitants live by agriculture alone, while on agriculture combined with fishing there depends 16 per cent of the population. In spite of the short growing season, the exportation of dairy products has largely increased within the last ten years, and at the present time 300,000 lb. of butter are annually produced. The trade in Iceland ponies is considerable, and during the year 1900 over 3000 were exported, nearly all to Scotland and England, while in the same year mutton and wool returns amounted to £90,000. In 1907 about 2400 ponies were exported to Britain (see ICELAND PONIES). From the beginning of October till the end of May the ground is frozen to a depth of from 2 to 3 ft. The vegetative season lasts only for three or four months, and on this account the cultivation of cereals is impossible. Within recent years, however, turnips and potatoes have been successfully grown, and the acreage under these crops is increasing. But the farming is mainly pastoral, the dairy cows and the milking sheep being maintained throughout the winter on a supply of hay only.

DAIRYING.—The dairy industry has rapidly increased within the past decade, and if the present progress is maintained, there is no reason why the exportation of butter should not amount to 1,000,000 lb. per annum. The Icelandic dairy cattle are a distinct breed, and though they have descended from Norwegian ancestors, yet since their introduction little admixture with alien blood has taken place, so that the race may be regarded as practically pure. The breed has been greatly improved of late by associated societies of farmers, the members of which mutually control the breeding. The average weight of the cows is about 7 cwt. The average yield of milk is between 4000 and 5000 lb. per annum, with from 3 per cent to 4 per cent butter fat. Some of the best herds have been known to give a yield of 8000 lb. This is certainly remarkable, considering that the cows can only be grazed for about three months, and that for the rest of the year they are fed on hay alone. Most of these dairy farms are small, each farmer having from two to six cows and from seventy to eighty milking sheep. The size of the individual farms varies greatly, but where good pasturage and broad meadows predominate, each farm only occupies a few acres. The sheep farms in the inland and uninhabited portions of the island often cover several square miles. Each farm has attached to it a 'home field', which varies from 3 to 30 ac. in extent. This is the only part of the farm which receives any manure, and when well managed gives very good returns in hay and pasturage. It is here that the dairy cows and the milking sheep are grazed in the summer. During autumn, winter, and spring, cattle are turned on to it when not in the stalls. The milk from these farms is sent to small creameries; but as the distances between the farms are often very great, each creamery or dairy factory is supplied only by a few farmers—from nine to forty-four. It is seldom that each factory has as many as fifty-five members, yet the average output from the various units is from 1½ to 2 cwt. butter daily during the best seasons. This shows the great enterprise of the agricultural community. The industrial spirit is being fostered by the Danish Government, which grants loans for the building of dairy factories. The dairy need not be large, and the grant of £150, repayable in fifteen years, is sufficient to erect suitable buildings. Owing to the long distances apart of the farms, and the bad state of the roads, only cream is sent to these central depots, and it is conceivable that if whole milk were sent, much larger returns might be realized. The great drawback to the dairy industry is that butter can only be produced for two-and-a-half to three months of the year, and that as few steamers sail to the United Kingdom—the chief market for the produce—the butter has often deteriorated before

it reaches its destination. No steam appliances can be employed in the factories on account of the scarcity of fuel, the employment of which would make the working expenses too high; hence water power is mainly utilized, and in some cases horse power. In the smallest factories, hand power is resorted to.

Sheep.—In Iceland, sheep are kept not only for the production of wool and mutton, but also for the milk they yield. The sheep form a distinct breed, though great variations occur. They are coarse in the wool, long in the legs, and have a short tail. The milking sheep are kept indoors during the winter and fed on hay. They are turned out about the end of April, and commence lambing about the middle of May. The lambs are allowed to run with their mothers for about a month, after which they are weaned. The ewes are then milked every morning and evening. As a rule, each sheep yields from 10½ to 12 gal. of milk during the summer, and it is reckoned that 2½ gal. of this milk produces 1 lb. of butter. Sheep which are kept for the production of wool and mutton are reared on the large sheepruns in the inland. Those intended for consumption and for exportation are killed in September. Various societies have been recently formed to improve the breed, the chief aim above all being to produce a healthy and fleshy sheep. [A. H. S.]

Iceland Moss is the lichen *Cetraria islandica*. It is found in Scotland, and is widely distributed over the northern hemisphere. It is the dried thallus which is used as a drug or food. This is a brown or greenish-brown cartilaginous material, which is lighter, almost grey, on the under side. It has no smell, and has a slightly bitter mucilaginous taste. The chief constituent of Iceland moss is the carbohydrate lichenine. This body is slightly soluble in cold water, but dissolves in hot water to an opalescent solution which gelatinizes on cooling. Hence a 5-per-cent decoction of Iceland moss gelatinizes on cooling. When boiled with dilute acids, lichenine yields a sugar. Other substances found in Iceland moss are cetraric and lichenostearic acids. It is to these bodies that it owes its bitter taste. The bitterness can be removed to a great extent by treatment with water. Iceland moss is useful in medicine chiefly for its demulcent properties. It is used in the form of a 5-per-cent decoction, or in the form of a jujube, after removal of the bitter principle. It is also used in northern Europe as a food, and jellies are prepared from it along with sugar and other substances. [J. H.]

Iceland Ponies.—The ponies of Iceland are chiefly interesting because they retain many of the traits of the small horses which in prehistoric times ranged over north-western Europe, and because during the last forty years they have been used in ever-increasing numbers in English and Scottish coal mines. The majority of the ponies now bred in Iceland stand about 12 hands at the withers; but in olden times, when 'horse-fighting' was a favourite amusement, the ponies of Iceland seem to have often measured 13 hands, and individuals with powerful jaws seem to have been preferred. Even now, strong 13-hands ponies are met with in Reykjavik, and occasionally well-bred small cobs measuring approximately 13 hands are exported to Denmark. Of the many thousands of Iceland ponies landed at Newcastle and other ports during the last forty years, the majority have found their way into coal mines; but in addition to working in pits, Iceland ponies now do most of the light work in towns and villages over a considerable part of England and Scotland, and they seem to be displacing the donkey in various parts of Ireland. In Iceland the ponies are used for riding and as beasts of burden. Apparently pacers are preferred; but whatever the make or the gait, it is essential that they be hardy, and capable of surviving during winter on a limited amount of indifferent fodder—it is even stated that in times of scarcity the ponies partly subsist on fish. One result of their hard upbringing is that they often become so fat in England (on a by no means liberal diet) that they move with difficulty and become sterile.

A herd of Iceland ponies generally includes three distinct types. To begin with, there is a stout, broad-browed variety, characterized by a short, dished face, short ears, and an elk-like muzzle, by a short thick neck, a long body, rounded hind quarters, coarse limbs, short pasterns, and broad hoofs. In these ponies, which belong to what is now known as the 'forest' type, the face, instead of being deflected as in sheep, is nearly in a line with the cranium; the muzzle is broad, and the cheek teeth have the long 'anterior pillar' which distinguishes the species *caballus* from the ancient Pliocene species *stenonis*. Further, in this broad-browed variety with a short face and a low-set-on tail, the limb bones are short and massive. This is especially true of the metacarpal. Moreover, typical broad-browed Iceland ponies have a complete set of callosities (four chestnuts and four ergots), and in addition to a broad dorsal band have often bars on the legs; sometimes there are stripes across the withers, and vestiges of zebra-like markings under the forelock. Judging by the teeth, the metacarpal and other limb bones, the robust, yellow-dun, more or less striped Iceland ponies represent the small horses which during the Early Stone Age were extremely abundant in the Rhone valley. In addition to several members of the robust 'forest' type, a large herd of Iceland ponies generally contains two or three members of the 'Celtic' type—a race characterized by a narrow face, large eyes, small ears, and a fine muzzle; by a long neck, short strong back, and a well-set-on tail, which in the winter has a large bunch of hair (taillock) at the root; by slender limbs, long pasterns, and small hoofs, and by the absence of the hind chestnuts and all four ergots. The members of the Celtic variety, though also of a yellow-dun colour and carrying during winter a heavy coat, have only a very narrow dorsal band, and the merest vestiges of bars on the legs. They differ from the 'forest' ponies in having the face narrower and more deflected, the 'pillars' of the cheek teeth short, five instead of six loin vertebræ, sixteen

instead of eighteen caudal vertebræ, and the metacarpals so long and slender that the length is over seven times the width. These slender-limbed Celtic ponies seem to belong to a species which lived during preglacial times in Auvergne and other parts of the Continent.

A third variety is also represented in Iceland—viz. the 'Steppe' variety—which still exists in a wild state in Mongolia. Evidence of 'steppe' or Prejevalsky blood we have in ponies characterized by a long, narrow, coarse face, a poorly developed forelock, a mane which arches to one side rather than clings to the neck, a somewhat mule-like tail, fairly slender limbs, and narrow hoofs.

But though in most herds of Iceland ponies one generally finds two or three nearly typical members of the 'forest' and Celtic varieties, and individuals which in one or more points suggest the Wild Horse of Mongolia, the majority are a blend of the Celtic and 'forest' types. It is probably because the majority of Iceland ponies are crosses or hybrids between two ancient wild types that so many of them are of a chestnut or leather-dun colour.

The crossing of Iceland ponies with Arab and other stallions produces varying results. Sometimes the crosses are well made, active, and hardy; at other times, in make, colour, and action they are disappointing. The explanation of crosses being sometimes excellent, sometimes indifferent, is that Iceland ponies belong not to *one* race but to *several* races, which, notwithstanding centuries of intercrossing, have not yet blended to form a distinct breed. In all probability a number of horses originally reached Iceland direct from Norway, but perhaps the majority were imported from the Western Islands of Scotland. [J. C. E.]

Ichneumon (Trogus) atropos.—This is a parasite upon the caterpillar of the Death's-head Moth (*Acherontia atropos*). The female lays her eggs in the caterpillars, where they change to maggots and pupæ, and from thence issues this fine ichneumon, whose wings expand nearly 2 in. It is of an orange colour; the extremities of the antennæ and four terminal joints of the body are black; the crown of the head and trunk are also black, the latter with two lines, and the scutel ochreous; the wings are deep-yellow, with smoky margins.

I. (*Peltastes*) *dentatus* is another fine ichneumon, which destroys the large caterpillars of *Lasiocampa trifolii*, feeding upon the different clovers. The fly is dull-black; the antennæ are orange beneath. The trunk has some yellow spots, and the segments of the body are margined with the same colour; the shanks and feet are bright-yellow; the wings are smoky, and expand nearly 1½ in. [J. C.] [F. V. T.]

Ichneumonidæ (Ichneumon Flies), a family of parasitic Hymenoptera, whose larvæ live in other insects. The majority are largish species, with long ovipositors, and abdomen either sessile or petiolated; four membranous wings, and elbowed antennæ. There are very large numbers of these useful insects. Most of the true ichneumons are black, either with red legs, or with the antennæ, legs, parts of the thorax varied with yellow, and the abdomen mostly red or yellow. Those with very long ovipositors mostly belong to the so-called Pimplinæ. One of the best known is a large black insect with the thorax and sides of the long narrow abdomen spotted with pale-yellow. It is about 1 in. long, the ovipositor, composed of three long slender bristles, fully twice as long as the body. It occurs in fir woods, and by means of its long ovipositor it drills a hole in the bark and wood and deposits the eggs in the larvæ of the Wood Wasp (*Sirex gigas*). The name of this parasite is *Rhyssa persuarica*. [F. V. T.]

Igneous Rocks.—Rocks broadly divide themselves into those formed by consolidation from a molten state (igneous rocks) and those formed from the decay of others. The latter types are usually laid out in strata (sedimentary rocks). On the supposition that our earth was once in a molten condition, the oldest rocks, as well as those now in its interior, should be igneous, and it seems probable that all our limestones, clays, and sandstones have been derived originally from the decay of igneous masses. The lavas of volcanoes at the present day cool as solid rocks, and their constituents assume a crystalline state, if the process is sufficiently slow, or remain as a glass where cooling goes on rapidly. Most lavas thus contain some residual glass. Down below, however, the caldrons of molten matter must cool with extreme slowness, and will ultimately give rise to completely crystalline rocks. Just as crystals of one kind may separate out before others, so the mass may divide itself into materials of different compositions, and these, when exposed by denudation, give rise to very different types of soils and surface. The igneous caldron, moreover, spreads from the depths upwards by absorption and solution of its walls, and certain parts of its contents, rich in dissolved materials, become thus modified in composition. Again, it is highly probable that denser and less siliceous matter occupies the lower zones of the earth's crust, while more siliceous matter, such as that yielding granite, lies above it. The protrusion of the 'basic' matter from below, and its occasional commingling with the 'acid' matter traversed by it, gives us a variety of igneous rocks in the surface zone on which we work. The amount of silica in igneous rocks ranges from about 80 down to 35 per cent, the alkalis being prominent in the most siliceous or 'acid' division, and lime, magnesia, and iron oxides in the 'basic' division. The materials of the crystalline masses, when first exposed, are largely anhydrous, and weathering promotes oxidation and combination with water, while valuable constituents, such as lime, phosphoric acid, potash, and magnesia, become slowly added, in soluble forms, to the resulting soils. [G. A. J. C.]

Impaction.—Accumulations of indigestible material in the stomach and bowels are elsewhere mentioned in connection with constipation, colic, ruptured gut, stomach staggers, and as contributing to megrims and otherwise having a prejudicial influence upon the circulation

in the brain and other organs. Impaction in cattle is generally understood to refer to the third stomach or omasum, fardel, or maniplies, and is variously known as *clue bound*, *fog sickness*, *staggers*, and *vertigo*. It is now generally regarded as secondary to some digestive disturbance in which the supply of fluid is arrested from the salivary glands and other sources which normally provide waves of liquid, floating the finely divided food from the mouth of the rumen to the third stomach. The omasum or third stomach is dependent for its moisture on the overflow from the other dilatations, commonly described as separate stomachs, but only differing in their functions as part of a whole, and any arrest of their normal activities must result in alteration of the contents of the omasum. The particles of food between its leaves are normally much drier than ingesta examined in the rumen or reticulum. It is, however, probable that impaction of this viscus arises from other causes not immediately connected with the other food receptacles, as it is innervated from a different source.

The *symptoms* are generally recognized, and consist in dullness and discomfort, passing on to abdominal pain, the patient persistently standing, and giving expression to a grunt or groan at the end of each expiration. The fæces are glazed and hard; obstinate constipation following, except in a few instances where a very narrow stream of fermented dung passes through dry caked fæces lining the canal. This latter symptom is particularly misleading, as the need for an aperient is not demonstrated until it is found that dry solid masses come away as the result of purgative medicines. If not relieved, brain symptoms follow, the eye is insensitive to light, there is a staggering gait, muscular tremors, or paralysis. The effects of brain pressure due to disordered circulation within it, vary according to the parts most concerned, as well as in individuals, hence we find torpor and paralysis in one beast, and wild excitement in another, with protrusion of the tongue, which rapidly swells. The stoppage also gives rise to tympany or hoven, from failure of the intestinal gases to escape. The pulse is hard and frequent; the eyes staring, and conjunctival membranes injected. *Treatment* is directed to the softening of the contents by repeated doses of linseed oil, and the administration of salts very largely diluted. A few ounces of sulphate of magnesium in a gallon of warm water at intervals of four or five hours will prove more effective than twice the quantity of the drug in only sufficient water to dissolve it. Croton oil in 15- to 20-drop doses is employed by some, while others prefer hypodermic injections of 1 to 2 gr. of eserine, 1 gr. of veratrine, or 3 gr. of pilocarpine, or 10 to 15 gr. barium chloride. Powdered ice in bags, or cold swabs applied to the poll, has a calmative effect upon beasts showing great excitement. [H. L.]

Implements, Agricultural—Classification of.—Implements may be classified under a considerable number of heads, and are subject to much subdivision in order to clearly define their purpose. The list has been so much extended during recent years that the few headings at one time considered sufficient do not now indicate all that requires to be shown. It is not desirable to make fewer divisions than are set out in the following schedule.

TILLAGE.—*Ploughs.*—Single-furrow, double-furrow, turnwrest, multiple or gang, ridging, water-furrow, potato-digging, chill breast, Kentish, subsoil, reclamation, wheeled, swing.

Cultivators.—Grubbers, scarifiers, scufflers, shims, nidgets, sickle-tine (spring and rigid), drags.

Harrows.—Zigzag seed, drag harrows, flexible, wooden frame, wheeled drags.

Rollers.—Wooden, stone, iron, single-cylinder, double-cylinder, smooth-cylinder.

Clod Crushers.—Cambridge, ribbed, notched.

After Seeding.—Horse hoe, turnip thinner.

SEEDING IMPLEMENTS.—*Drills.*—Corn and seed, manure, potato planter.

Broadcasters.—Corn and seed, dry manure, farmyard manure distributors.

HARVESTING (*Corn*).—Reaper (manual and self-delivery), binder (with vertical canvases and without vertical canvases), horse rake, stacker, pea cutter.

HARVESTING (*Hay and Clover and Grass Seed*).—Mower, rotary tedder, kicker tedder, swath turner, collector, field-elevator loader, stack elevator, horse rake, thatch-making machine, section sharpeners.

Silage.—Mechanical pressers.

HARVESTING (*Special Crops*).—Potato raiser, turnip lifter, hop bins, hop press, cider press, apple pulper.

PREPARING FOR MARKET.—Engine, threshing drum, clover sheller, straw elevator, winnower, Roby screen, rotary screen, aspirators, cockle cylinders, Dossor's plush seed cleaner, hay press, weighbridge.

FOOD-PREPARING.—Mills, grinders, crushers, chaff cutter, litter cutter, steaming plant, root pulper, root slicer, cake breaker.

DAIRY.—Milking machine, separator, refrigerator, railway churns, butter churns, centrifugal drier, cheesemaking plant, sterilizing plant, pasteurizer, milk float.

LIVE STOCK FEEDING, ETC.—*Cattle.*—Mangers, cribs, cattle float.

Sheep.—Troughs, hurdles, racks, dipping plant, clipping machine, shelter cloths, lamb creep.

Horses.—Harness.

Pigs.—Troughs, pig rings.

Poultry.—Chicken house, incubators, foster-mother, crammer, bone crusher.

PRIME MOVERS AND SOURCES OF POWER.—*Steam Engine.*—Locomotive, portable, fixed, coal-heated, wood-heated, straw-heated.

Oil and Paraffin.—Automobile tractor (suitable for all classes of work), portable and fixed.

Gas Engine.—Portable and fixed.

Suction Gas.—Fixed.

Wind Motors.—Fixed and self-moving.

Electric Motor.—Fixed and tractive.

DRAINAGE AND LAND-RECLAMATION.—Drain ploughs for making open grips, mole ploughs, rotary excavators (with apparatus for laying and covering the drain pipes), Sutherland plough, Duke's toothpick.

Water Supply.—Pumps, hydraulic ram.

Haulage.—Carts, wagons, lorries—horse-, steam-, oil-engine drawn. [w. j. m.]

Implements, Agricultural—History of.—The history of agricultural implements is singular in that, although agriculture is the oldest art and has been pursued unremittingly through such a vast period, and in countries boasting a high civilization, there is little to show that machinery and implements ever reached a high state of efficiency until within the past century and a half; and it is particularly during the last half-century that the methods of the ancients have been improved upon. No machines recorded in manuscript, tapestry, or on monument suggest that there has in any age been the equivalent of the modern large agricultural engineering firms, with highly trained engineers to apply scientific principles to invention. Moreover, writers during times of ancient civilizations have transmitted little to us that suggests the use of complex machines, though they have described in detail many of the simple hand tools and implements employed in their time; and these tools had to effect the operations of cultivation and harvesting, even where there was an extensive agriculture. That man wished to throw the burden of labour on others is shown by the early use of the plough, which has an unknown remoteness in the East, and which was manufactured both in Germany and Gaul a thousand years before the birth of Rome; and Roman writers acknowledge their indebtedness to Egypt, Phœnicia, Greece, Germany, and Gaul for their implements of husbandry. Pliny described a Gallic reaping machine, and Varro mentions one he saw in Germany, thus showing that there was long ago a desire to lighten the labours of harvesting; but these ox-drawn machines were only strippers, which snatched or stripped the ears of corn from the straw as a series of closely set prongs were drawn through the crop. Threshing machines did not advance beyond the flail or 'the ox that treadeth out the corn', except that rollers were drawn over the threshing floor, as in the case of the Roman tribulum. In the after-treatment of the grain, in the grinding, mechanical help was obtained from mills such as the Egyptian, Pompeiian, and others; while Livingstone found a rude roller mill in use among some of the African tribes. From the Assyrian monuments there is evidence that at least 500 years before the Christian era a drill plough was in use. Through the centuries which followed, but little improvement or innovation occurred, and over a large portion of the world the machinery has little altered during the past 2000 years, though even in the most backward countries the influence of modern machines is being felt. In view of the great development of machinery, which has supplied a mechanical substitute for almost any operation which man himself had to labour to perform on the farm, it is difficult to realize that there was little advance made, even in western Europe, before the 18th century had been entered. There is therefore little that has been gained from the ancient past. The last 150 years has, however, been a period during which profound changes have been made, and the inventive genius of man has produced machines of great ingenuity. How simple were the machines at the inauguration of the Royal Agricultural Society's shows in 1839 is graphically described by Mr. Parkes's report in the following words in 1841, when he said the implements then were for the most part 'crude, cumbrous, and ill-executed machines, the work of village ploughwrights and hedge-side carpenters'. Illustrations of machines of that date or previously, show the truthfulness of this statement; but from that time to the present there has been a rapid and consistent improvement in construction as well as in principle. A good illustration in the progress made is shown by the economy of coal secured in engines competing in the Royal Agricultural Society of England trials—the prizewinner in 1849 burned 11½ lb. of coal per horse-power per hour; in 1850, 7½ lb.; in 1852, 4⅝ lb.; in 1855, 3¾ lb.; in 1872, 2¾ lb.; in 1887, 1⅘ lb., and now so little as 1 lb. per hour. The first compound engine seen in the 'Royal' show ground was one made by Messrs. John Fowler & Co. In regard to implements, it has been an evolution from wood to iron, and from iron to steel; and this is emphatically the steel age on the farm, lightness and strength being in evidence in all sections. Although the development of machinery has been so great during the past seventy years, and things undreamed of before that period have long been established and held as necessary by large and small farmer alike, there were in some cases crude implements, the parents of the highest development of to-day; and in some instances the principles had been evolved during the awakening period in British agriculture, which began about the middle of the 18th century and gathered strength as the century grew older. Among the notable machines which had their birth in the 18th century, none is more valuable than the corn-threshing machine, though, of course, the application of steam as an agricultural prime mover stands out as the most important, Watt having patented a portable engine in 1784; but the threshing machine invented by Meikle in 1788 came into frequent use before the end of the century, he having associated the rotary drum with the sparred concave, which is the principle of threshing in modern-made machines. As early as 1735, Menzies had started to invent a threshing machine, and made one in which a number of flails were made to beat upon the floor; and later he constructed one with two rollers, one cellular and the other with fluted surfaces, by which he hoped to squeeze the grain from the straw. Meikle associated the striking and the rubbing action, and nothing has been found to supersede it, though much has been done to improve the separations and cleaning of the grain subsequently. Trevithick's fixed engine was used to drive a threshing machine in the early years of the 19th century, and Lester in 1814 produced a steam traction engine for moving as well as driving the threshing machine. By gradual evolution the threshing machine has become practically a perfect separator and finisher,

but the possibility of this was instituted when Meikle made his invention.

The seed drill was inefficient until 1783, when Cooke patented one which was the foundation of subsequent drills. Many changes were made; but it is only during the past twenty years that they have been made with sufficiently light draught, and even now the steerage leaves much to be desired. The introduction of various forms of 'feeds', other than the original cup feed, gave the opportunity of lightening the box; and the substitution of coulters which lightly shoved out a seed track in the place of those which pressed out a track, greatly lightened the draught, as so much friction was avoided. Drills and distributors for sowing artificial manures are necessarily of modern development, as it is only within comparatively recent years that concentrated fertilizers have been used.

The development of corn growing in the Colonies and newly developed country only became possible through the introduction of harvesting machinery, particularly of the 'binder', for in these countries there has never been a sufficiency of manual labour to handle the big areas under corn cropping. The ancient strippers were improved upon by William Pitt of Pendeford, whose machine is described in Young's Annals of Agriculture, p. 161; but John Common of Denwick, Northumberland, in 1812 laid before the Society of Arts a machine embodying the essential principles of the modern reaper, having reciprocating knives, open finger guards, a swath delivery, and a reel bringing the standing corn to the cutters. In respect to the future progress of the reaper, Mr. Dan Pidgeon, whose association with agricultural machinery during many years was exceptional, and whose writings on the subject of ancient and modern machinery were most reliable, wrote in the Journal of the Royal Agricultural Society of England in 1892 (vol. iii, part 1 of the 3rd series) the following paragraph, which is important as bearing on the history of the reaping machine: 'In the course of his experiments, Common had recourse to the Browns, father and son, of Alnwick, clever mechanics and founders, who substituted iron for wood in many parts of his machines, and themselves became, later, makers of an improved machine, which was sold in some numbers about 1822. In 1824 the Browns left Alnwick and shortly afterwards emigrated to Canada, taking with them models of Common's reaping machines. Ultimately they moved to Sterling, in Cayagua County, New York State, where the father became a farmer, and so died in 1850. M'Cormick, the reputed originator of the reaping machine, lived at Auburn, about twenty miles from Sterling, and knew the Browns well. From them he obtained a model and description of Common's machine, and there is little doubt that the reaper with which he competed at the trials of harvesters, held at Auburn by the New York State Agricultural Society in 1846, was the child of those models, and the father of the M'Cormick machine which obtained such notoriety at the London International Exhibition of 1851.' The Rev. Patrick Bell invented the endless apron; but the credit of the introduction of the binder, the possibility of which was made by the invention of the knotter of the sewing machine, was due to American enterprise. Mann of Clinton, Ohio, invented the vertical apron in 1849; the firm of Watson and Renwick added a mechanical binding device in 1851, the forerunner of the binder of to-day, using string, which failed then in practice. The Wood and Lock firm in 1867 brought out the wire binder; Appleby in 1878 produced the string binder, which is mainly used by British makers; and the firm of Wood and Holmes brought out theirs in 1879. In 1889 Wood showed his straw binder, which made fair work, but string is relied upon now in all cases. The use of the two aprons horizontal and vertical (nearly) is almost universal, but the Adriance Platt Co. of Poughkeepsie have demonstrated clearly that the vertical apron can be dispensed with satisfactorily.

Cultivators, that is implements for stirring land, have passed from crude forms, where tines were held fast in rigid frames, to lighter frames with mechanical devices to raise and lower tines. Until now the sickle-tine cultivator, with more or less rigidity or flexibility in the tine, dominates; and there is every sound reason to suppose that all other forms must become obsolete. The use of the sickle tine in cultivating is an adaptation of the same tine invented by Hart of Woburn, who made the first horse rake with a curved tine and a rocking frame, and therefore gave the agricultural world two implements of great value, for which he has had little credit.

Haymaking machinery has been developed so much during recent years that hand work has been almost ousted, except on very small or uneven fields. The mower, which is sister to the reaper, and has for a long while been responsible for the cutting of the greater portion of the hay crop, has been supplemented by the haymaker, which has passed through the stages of rotary tedder (first made by Salmon in 1814), the kicker tedder of American origin, the swath turner (invented by Jarmain of Tisbury), and the collector, an adaptation of the swath turner for turning and sweeping two more rows into wind-rows, and so making ready for the field-elevator loader to pick up.

As the ox-drawn plough was the first implement, so ploughing still attracts lively attention now. Steam ploughing after sixty years of trial, although not a mechanical or commercial failure, has failed to answer the anticipations of its sponsors, and though used on some appreciable scale, possesses drawbacks which prevent its general adoption. The last few years have demonstrated the practicability of the oil-driven automobile and its suitability for ploughing, where it takes the form of a motor, which will perform the many operations hitherto dependent upon horses and steam. The agricultural motor tractor performs the work of ploughing more cheaply than it can be done by any other power, and if it were only on its merits as a ploughing engine, will come into use as prejudice to novelty wears away; but as it is workable in one way or another on the farm practically every day, it is

destined to become the first power on the farm. Messrs. Priestman Brothers were the first to prove the suitability of the petroleum motor to farm work in a portable engine in 1890, while H. P. Saunderson, of Bedford, made the first agricultural motor tractor in 1892, which he applied to plough and general work. Since then it has been greatly developed, and he took the most recent award of the Royal Agricultural Society with a motor of 50 h.p. weighing 3 tons. Electricity has been applied to ploughing, but only little more than experimentally. The possibility of using it is undoubted, but its practicability has yet to be demonstrated.

[W. J. M.]

Implements, Horticultural.—The tools and instruments used in horticulture are exceedingly numerous and varied. A handy man can accomplish much with a spade and pruning knife; still, there are many operations in the garden which can only be properly performed by means of appropriate tools. Even the spade has to be adapted to the various soils and the nature of the operation for which it is used. The English spade is the best for use in countries where the soil is heavy and adhesive, but it is not so good for light sandy soils such as that of Holland. We prefer what we have been taught to use, and notwithstanding various changes in shape and weight, our garden spade of to-day is practically the same as that used in England centuries ago. Next in importance is the fork, particularly the broad-pronged variety, used for digging. This is a tool which the garden labourer might use with advantage a great deal more than he does. The mattock is a kind of pickaxe, which can be used for many purposes in the garden, and the small form of it, known as a hand pick, is another most serviceable tool. The garden rake requires no description; but whilst the iron form is almost universally used, the larger wooden rake, after the style of a hay rake, is far more appropriate for many soil-combing operations, and should certainly be included in every collection of garden tools. The Dutch hoe or scuffle is the best of all tools for cutting out weeds in summer and at the same time loosening the surface soil; the draw hoe requires to be on the small side, with a strong curved neck and a really sharp blade, to enable the workman to get the best out of it. An iron crowbar with one end pointed and the other chisel-shaped is frequently in demand in the garden. Knives are required for pruning, cutting-making, budding, and a hundred-and-one other operations, and there are various kinds made for special purposes. Shears, sécateurs, scissors, saws, and, of course, scythes, must be provided in establishments where there are shrubs and lawns to be dressed and kept in order. The lawn mower is now so greatly improved and simplified that it should be provided wherever there is grass to be kept trim. In large gardens the motor lawn mower is used. A good hose pipe is indispensable wherever artificial watering has to be resorted to, and it will be found cheapest in the end to secure one of the best quality. The water-barrow is another useful tool, and of course the wheelbarrow and truck basket are almost as necessary as a spade. Ladders, bell-glasses, hand-lights, watering cans, syringe, vaporizer, and fumigating apparatus are other necessary tools. A list of some of the most essential horticultural implements as used in the British Isles, is here given. Separate articles treat of the different tools.

All garden tools should be kept in working order. A properly equipped toolhouse, with hooks for hanging, shelves and cupboard for small tools, is an indispensable adjunct to gardens of large size. Wherever tools are kept it should be in a dry place, and after use they should be cleaned before being put away. Not only are well-cared-for tools in better condition for doing work well and expeditiously, but they last much longer than when they are allowed to get rusted and otherwise out of order through neglect.

List of Tools

Spade.	Hedge shears.
Shovel.	Lopping shears.
Mattock.	Edging shears.
Grubbing axe.	Pruning shears.
Drag.	Pruning saw.
Daisy rake.	Tree pruner.
Digging fork.	Sécateurs.
Manure fork.	Flower gatherer.
Hand fork.	Billhook.
Dutch hoe.	Scythe.
Draw hoe.	Asparagus knife.
Turf cutter	Saw.
Verge cutter.	Lawn mower.
Dibber.	Water harrow.
Trowel.	Wheelbarrow.
Turf beater.	Spraying pump.
Rammer.	Watering can.
Suckering iron.	Hand-light.
Hammer.	Bell-glass.
Pruning knife.	Truck basket.
Budding knife.	

[W. W.]

Imports, Agricultural.—The growing volume and varying character of the agricultural imports of the United Kingdom directly influence both the profits and the methods of British agriculture, although it is not always easy to define exactly the precise scope of those sections of our oversea trade to which the term agricultural imports may properly be applied. Nearly all the primary products brought to our shores have their origin in the soil; and cotton, wool, and timber are as undoubtedly agricultural produce as grain or beef or butter. Some writers would limit the imports to be regarded as agricultural to food products only, and others would further narrow the list to those kinds of food which could be raised at home. This would exclude the sugar or the rice, as well as the wine and spirits, the tea, the coffee, and other beverages of foreign growth which so largely enter into our consumption here, and which at all events supplement, if they do not supplant, various forms of native produce.

For a work of reference like the present, it may suffice to select, from the exhaustive records of our import trade, which must be sought in the detailed returns of the Customs authorities, a few typical groups of food of animal or of vegetable origin, adding to these the feeding-stuffs and manures required by the British producers for the growth and manufacture of food

on our soil, as well as the large consignments of wool, of flax, of hides, and of wood, whereof the native growth fails to meet the requirements of our dense population.

An estimate of the value represented by the imports thus classed in the single year 1907 would give a figure exceeding £300,000,000. But from this there is a large re-export to be deducted; while a not inconsiderable export of native British produce must be allowed for before the net dependence of British consumers on foreign agriculture can be ascertained even approximately. These two classes of deductions would exceed £40,000,000 in value, the re-exports being over two-thirds and the British exports under one-third of this item. Considerably more than a quarter of a million sterling would still remain in the category of agricultural imports.

Food products form two-thirds in value of the agricultural imports, and one-third is required for industrial uses. Of the food imports those of animal origin represent nearly £97,000,000, and those of vegetable origin—largely grain and its products, but including also sugar, fruits, and vegetables—reached £112,000,000 in 1907. By deduction for the British produce exported and the re-exports of foreign arrivals, the first of these totals may be reduced to a net value of £92,000,000, and the second to £104,000,000. The gross value of the industrial group of agricultural imports reaches £92,000,000 (whereof wool and wood make up two-thirds of the whole), but the group must be reduced to little over £60,000,000 if account be taken of the more extensive exports and re-exports in the category. A still smaller figure would represent the net result if calculation be made of the value of the exported manufactures based on the foreign raw materials received in this country.

The largest single group of agricultural imports entering the United Kingdom in 1907 was made up of the meat supply received from abroad. This had received a gross value of £50,000,000, whereof one-sixth arrived in the shape of animals imported for food, and five-sixths came as beef, mutton, or pig-meat, preserved or fresh. Wheat and wheat flour came only second in importance, with a value of £44,000,000. Other cereal imports were nearly £27,000,000, while dairy produce and margarine made up £33,000,000 more. Timber was imported to a value of £29,000,000 per annum, and wool with a gross value of £32,000,000. From the last item, however (including waste and noils), more than half, or £16,560,000, should be deducted as a re-export. The various imports of hides, skins, and furs, flax and hemp, and seeds, oilcakes, and cattle foods, annually, also reach aggregates of formidable dimensions.

Comparisons of the growth of imports are best made in individual cases by quantities rather than by values, the level of which change materially from year to year. Contrasting the existing position with the period—forty years distant—wherein our accurate statistical knowledge of the conditions of British agriculture begin, it may be noted that while our population of consumers has grown by nearly one-half, or from 30,600,000 in 1866–70 to 44,100,000, the imported wheat supply is more than threefold, or 115,640,000 cwt. against 37,270,000 cwt., the imported dairy produce has multiplied fourfold, or from 2,000,000 cwt. to 8,400,000 cwt., and the growth of the foreign meat supply has outstripped even that ratio, the average imports of butcher's meat and live animals for food in the five years 1866–70 would not appear to have reached 2,500,000 cwt., while those of 1907 were nearly ten times this quantity, or 22,560,000 cwt.

Per head of the population we now import a yearly ration of over 27 lb. of fresh beef, mutton, or pork, together with some 20 lb. of bacon and hams and other forms of meat. The butter imports of 1907, including margarine, were alone nearly 13 lb. a head and the cheese 6 lb. per head, while 51 eggs per person was received from abroad within the year. These averages compare respectively with only one-fifth part of a single pound of beef, mutton, and pork imported in 1866–70 per unit of the population, and with 4 lb. per person of bacon, ham, and other preserved meats, while only one-third as much per person as at present was represented by the butter import of forty years ago, and about one-half of the ration of cheese now available. Only 14 eggs as against 51 was the average importation of the period thus referred to. The imported wheat supply of the country per person has not increased as rapidly as some other forms of food, but the 247 lb. of wheat in grain and 47 lb. of flour per head received in 1907 compare with 116 lb. in grain in 1866–70 and 16 lb. in flour forty years ago.

These typical contrasts may suffice to show the relative reliance in proportion to population at the beginning and end of an interval which has been distinguished by the characteristic agricultural changes of our time, and the development of new lands and of new and cheaper means of transport. It is, moreover, important to bear in mind that the growth of imports has been accompanied by a complete change in our sources of supply. There was a time when it was to our neighbours on the continent of Europe that we looked for the supply of the main factors of our imported food. As lately as a generation ago, more than half (about 56 per cent) of our imported breadstuffs came from Europe; now, although Russia and some south-eastern States still send us wheat, their average quota is under 15 per cent of what we obtain, while 62 per cent of the supply comes from either North or South America, and the fluctuating imports from India or Australasia between them add another 23 per cent to the total. The necessary resort to the more distant and less populous sources is also evident in the case of imported meat. The live animals imported for food came all from Europe at the earlier period above referred to: they now come almost wholly from the United States or Canada; while of the far larger receipts of dead meat the United States, notwithstanding some recent checks, alone supply us with about one-third of the whole — one-half of this falling in the category of pig-meat. The contribution of the British oversea possessions comes not far short

of a like proportion, or 27 per cent in 1907, and Argentina alone now sends 23 per cent of the dead meat imported. European meat exports to us are now limited to a sixth part of the total, Denmark, and in a minor degree Holland, being responsible for most of these. In the group of dairy produce more than three-fourths of the imported cheese comes from Canada alone, and although Europe continues to meet our wants as regards the greater bulk of our butter imports—where the Danish supply largely predominates—the Siberian provinces of Asiatic Russia and our own Australasian colonies have become very considerable exporters.

[P. G. C.]

Impregnation in Animals.—In the coitus of mammals the erected penis is thrust into the vagina, and by a reflex act the seminal fluid is injected into the duct. The nervous centre of the act seems to be in the lumbar spinal cord. The forcible emission of the seminal fluid is due to contractions of the muscles of the penis, and also to peristaltic contractions of the male ducts and the seminal vesicles when these are present. At the time of the coitus the female organs are, or should be, in a state of turgescence, analogous to that of the erected penis. The seminal fluid contains thousands of microscopic spermatozoa, which proceed by means of their locomotor tails to work their way up the uterus into the Fallopian tubes. They may be helped by peristaltic movements of the female ducts, which are often violent after the coitus, so violent indeed that the seminal fluid is sometimes rejected after the serving. It has been shown by experiment that spermatozoa always work *against* a current, and they thus make their way 'up' the Fallopian tubes against any 'down' current of mucus. The movement of the spermatozoa along the female genital ducts was first definitely demonstrated in 1843 by Martin Barry. They work their way to the upper part of the Fallopian tube, where they may meet a descending ovum; and in some cases they pass to the ovary itself. In the case of bats the spermatozoa received in a coition in autumn are stored in the uterus till the following spring, when ovulation and fertilization take place. This seems to be altogether peculiar, for there is nothing to lead one to believe that the spermatozoa of mammals can remain effective in the female duct for more than a short time. According to Hensen, a hen will lay fertilized eggs eighteen days after the removal of the cock; and when we take lower animals into consideration, we have extraordinary cases like that of a queen bee retaining effective spermatozoa for three years. When a spermatozoon comes near the ovum it is probably attracted by it in a manner that is not understood, though we label the phenomenon as 'chemotaxis'. It is well-known that mobile cells such as phagocytes, are 'attracted' to other cells or to nutritive substances from some distance. A spermatozoon bores into an ovum, and when it enters a rapid change comes about in the periphery of the ovum, which becomes non-receptive to other spermatozoa. If several find their way in, the result is abnormal segmentation, which comes to nothing. The gist of the fertilization process, as distinguished from the insemination, is the intimate union of the nucleus of the ovum and the nucleus of the egg. There is a mingling of the paternal and maternal inheritances, and there is a liberating stimulus which sets the egg developing.

[J. A. T.]

Impregnation in Plants. See FERTILIZATION IN PLANTS.

Impregnation of Timber.—The preservation of timber by impregnation with various preservatives, such as creosote, naphthaline, &c., is treated in the arts. DURABILITY OF MATERIALS, and TIMBER, PRESERVATION OF.

Improvements. See AGRICULTURAL HOLDINGS ACT.

Inarching, a method of grafting in which the scion is left attached to its own roots until it has united with the stock. A portion of the bark and wood being removed from each with a sharp knife, they are then bound together with grafting cotton, and the jointure is covered with grafting wax or clay. This method is rarely resorted to, being most employed for vines. Fantastic trees can be produced by planting a circle of young trees of the same kind round a central one and then inarching those of the circle on to the middle tree, the lower portion of which, when a union has been effected, can be cut away. [W. W.]

Inarching

Inbreeding, the persistent pairing of nearly related individuals. The term is practically synonymous with the vaguer term 'close-breeding', the confusing term 'inter-breeding', the technical term 'endogamy', and the slightly narrower term 'in-and-in-breeding'. An attempt is sometimes made to distinguish in-and-in-breeding as a frequent repetition of inbreeding, but this is unnecessary, since the idea of continuity is implied in the word 'breeding'. No special term is needed for an isolated or casual endogamous union. The term 'inter-breeding'—though much used by Darwin—should be given up.

When a desirable new variation occurs within a family, the breeder may seek to conserve it and to strengthen it by inbreeding. He may pair offspring with parent, brother with sister, and so on, and when the desired variation has a certain stability (the meaning of which we do not know) it may be secured by inbreeding to a large number of possessors. If the inbreeding is successful, the new quality may be increased in amount as generation succeeds generation, and its possessors become more and more prepotent in respect of that quality. That is to say, they hand on the quality to the offspring even when they are mated with forms not possessing the quality. It seems, then, that inbreeding is a method calculated to conserve, diffuse, and fix new variations. It is part of

the process of forming a new breed. Some variations are so 'unstable' that in spite of inbreeding they disappear at once; others are so 'stable' that they reappear even when there is no inbreeding. We do not really know how far the first steps in the formation of a new breed depend on the stability of the new variation and how far they depend on the inbreeding. At the same time, it is well established that some stable and important breeds of cattle have arisen under conditions involving extremely close inbreeding, and it is well known in horse-breeding that very valuable results have been reached by using the same stallion repeatedly on successive generations. Much success has attended the diligent inbreeding of varieties of tobacco and some other plants.

As an illustration of inbreeding we may refer to the pedigree of the Shorthorn bull Courtier, calved in 1896, in which we see that Champion of England (17,526) appears over twenty-five times, and 'on both sides of the house'. In his work on Animal Breeding (1903), Professor Thomas Shaw gives the following illustration:—

Two Hundred Per Cent (33,592)	One Hundred Per Cent (16,590)	Stoke Pogis 5th (5987)	Stoke Pogis (846 E.H.B.), 1259 Imp.
			Marjoram (3239), Imp. with Stoke Pogis.
		Leclair's Marjoram (36,355)	Stoke Pogis, as above.
			Marjoram, as above.
	Leclair's Marjoram (36,355)	Stoke Pogis (846 E.H.B.)	Young Rioter (751 E.H.B), by Rioter (746), Dauncey's.
			Essay, by Young Rioter.
		Marjoram (3239)	Dr. Syntax (240 E.H.B.).
			Magnet, by The Gipsy (354 E.H.B.).

In the seven male ancestors given in the above three generations, the blood of Stoke Pogis (846 E.H.B.) appears directly or in his sons five times, and appears twice in the dams. The blood of Marjoram appears five times in the seven female ancestors, and in two of the sires.

If inbreeding secures the diffusion, augmentation, and fixing of a good quality, it will necessarily do the same for a bad one, and the breeder must prevent this by selection. As this is not always easy, for instance when the bad quality is some subtle predisposition to disease, evil results are apt to follow prolonged inbreeding, *e.g.* loss of size, vigour, and fertility. The question naturally suggests itself how far these evils are intrinsically bound up with the inbreeding and how far they are merely incidental, but no secure answer can be given until the results of carefully controlled experiments are forthcoming. See also BREEDING, LAWS OF. [J. A. T.]

Inclosure Acts.—Inclosures of land were formerly carried out principally by means of private Acts of Parliament dealing with lands in particular parishes or districts. The Statute of Merton, 1235 (20 Hen. III, c. 4), and the Statute of Westminster, 1285 (13 Edw. I, c. 46), enabled lords of manors to 'approve' land from the waste, provided they left sufficient pasture for the commoners, and did not infringe on any common rights of turbary, piscary, or estovers; but these Acts only applied in favour of the lords of manors, and did not authorize general inclosures, and the powers thereby conferred are now limited by the Law of Commons Amendment Act, 1893 (56 & 57 Vic. c. 57).

Private Inclosure Acts became common about the beginning of the latter half of the 18th century, and it was under them that the greater part of the common and open land in England has been inclosed. It has been calculated that between 1719 and 1845 more than 4100 Inclosure Bills became law (Clifford on Private Bill Legislation, vol. i, p. 14). These Acts affected not only commons or waste lands on which the lord and his tenants had concurrent rights, but also the large tracts of arable and (in rarer cases) meadow commonable lands held in severalty for certain definite periods, at the end of which they became subject to certain common rights, which were formerly to be found in almost every village throughout the country. These open arable and meadow fields are well described in Seebohm's work on the English Village Community. They were generally divided into acre or half-acre strips separated by balks of turf (see art. BALK). One man would generally own several of these strips, amounting together to a 'yardland' or 'virgate' of 20 or 30 ac., but his various strips would not be adjoining, but scattered about in different parts of the field. Moreover, anciently the ownership of the strips shifted annually or from time to time according to manorial custom, so that a man's property would consist in one year of certain strips and in a subsequent year of certain other strips in the same open field. These strips of land were cultivated and used in severalty until the harvest or (in case of meadow) the ingathering of the hay, and after these periods were open to the pasturage of the stock of all the commoners as they pleased. The rotation of crops was secured by dividing the commonable arable land of the village into two or three large fields, so that while one or two fields grew wheat and lent corn, the other field might lie fallow every other year or once in three years (as the case might be), the custom imposing upon each commoner, who would have some of his strips in each field, the obligation of conforming to the common system of cultivation. It was principally the partition and inclosure of these commonable or open fields, rather than the inclosure of commons or waste lands subject to the usual common rights, which were carried out by the numerous private Inclosure Acts of the 18th and early 19th centuries. The object was chiefly the improvement of agriculture and the productive capacity of the land, which were much hindered by the common system of cultivation and user.

In 1845 a general Act was passed, called the Inclosure Act, 1845 (3 & 4 Vic. 31), for facilitating the inclosure and improvement of commons and lands held in common, the exchange of lands, and the division of intermixed lands.

Under this Act, commissioners were appointed to deal with all cases of inclosures, whose powers are now vested in the Board of Agriculture and Fisheries. The powers of the commissioners were applicable to 'all land subject to any rights of common whatever . . . all gated and stinted pastures . . . all land held, occupied, or used in common, either at all times or during any time or season, or periodically . . . all land in which the property or right of or to the vesture or herbage . . is separated from the property of the soil, and all lot meadows and other lands the occupation or enjoyment of the separate lots or parcels of which is subject to interchange among the respective owners in any known course of rotation or otherwise'. The New Forest and Forest of Dean are excepted from the purview of the Act, also village greens. The commissioners are directed to inquire into the expediency of proposed inclosures and to embody the conditions of the inclosure in a provisional order. When the order has been confirmed, a valuer is to be appointed to divide, set out, and allot land, and boundaries are to be ascertained. Watercourses, bridges, &c., may be made, and roads set out and made, stopped up or diverted, allotments granted for recreation grounds and for the labouring poor, and division made amongst the several persons interested in the land before the inclosure. The award is to be drawn up by the valuer, and confirmed by the commissioners. The Act of 1845 was amended by the Inclosure Act, 1846 (9 & 10 Vic. c. 70), the Inclosure Act, 1847 (10 & 11 Vic. c. 111), the Inclosure Act, 1848 (11 & 12 Vic. c. 99), the Inclosure Act, 1849 (12 & 13 Vic. c. 83), the Inclosure Act, 1852 (15 & 16 Vic. c. 79), the Inclosure Act, 1854 (17 & 18 Vic. c. 97), the Inclosure Act, 1857 (20 & 21 Vic. c. 31), the Inclosure Act, 1859 (22 & 23 Vic. c. 43), the Inclosure Expenses, &c., Act, 1868 (31 and 32 Vic. c. 89), and the Commons Act, 1876 (39 & 40 Vic. c. 56). The procedure for the regulation and inclosure of commons is now governed by the last-mentioned Act.

The Board of Agriculture and Fisheries may under this Act entertain an application for the regulation of a common or for the inclosure of a common or parts of a common, but are not to proceed to carry any application into effect unless it is made to appear to them that the persons making the application represent at least one-third in value of such interests in the common as are proposed to be affected by the provisional order (sect. 2). A provisional order for the regulation of a common may provide generally or otherwise for the adjustment of rights in respect of such common and for the improvement of such common (sect. 3). 'Adjustment of rights' is defined in sect. 4 of the Act, and includes many matters with regard to various rights of commoners and the lord. 'Improvement of a common' is defined in sect. 5, and includes draining, planting, making by-laws, appointment of conservators, and other matters. Previously to making an application to the Board the applicants must give notice by advertisement of their intention to apply for a provisional order, and on making the application they must furnish information to the Board as to the expediency of the application considered in relation to the benefit of the neighbourhood, as prescribed by sect. 10 of the Act, and in the case of an application for inclosure special information is required as to the advantages the applicants anticipate to be derivable from the inclosure of the common as compared with its regulation. Evidence must also be furnished as to the private interests involved (sect. 10). If a prima facie case is made out, a local inquiry will be held by an assistant commissioner, who will report to the Board (sect. 11). If satisfied by the report of the assistant commissioner, or by further inquiries made by themselves, the Board will frame a draft provisional order for the consideration of the persons interested in the common, and the provisional order will not be certified to be expedient unless the Board is satisfied that persons representing at least two-thirds in value of such interests in the common as are affected by the order consent thereto. When certified, the provisional order is submitted to Parliament for confirmation (sect. 12). The regulation or inclosure of the common will after the confirmation be proceeded with. A valuer will be appointed and an award made, as provided by sect. 104 of the Act of 1845, and when confirmed by the Board the award will be conclusive evidence that the directions of the Acts have been obeyed (Act of 1845, sect. 105).

Commons lying wholly or partly within the Metropolitan police district do not fall within the Commons Act, 1876, but are regulated by the Metropolitan Commons Acts, 1866, 1869, 1878, and 1898, which contain special provisions for their improvement, and the framing of by-laws and regulations for the prevention of nuisances and to preserve order.

The Commons Act, 1899 (62 & 63 Vic. c. 30), empowers councils of urban or rural districts to make schemes for the regulation and management of any common within their district, with a view to the expenditure of money on the drainage, levelling, and improvement of the common, and to the making of by-laws and regulations for the prevention of nuisances and the preservation of order. Any scheme so made must be approved by the Board of Agriculture and Fisheries, and thereupon will have full effect (sect. 2). Metropolitan commons are not affected by this Act, nor any commons which are regulated by a provisional order under the Inclosure Acts (sect. 14). See art. COMMONS.

[A. J. S.]

Income Tax.—This tax was first imposed by Pitt in 1798 to meet the expenses of the war with France, and at the conclusion of peace in 1801 it was abolished. On the renewal of the French war in 1803 it was again imposed, and continued till the conclusion of the war in 1816. In 1842 Sir Robert Peel reimposed the tax, not for purposes of war but for general revenue purposes, and since then it has been one of the principal sources of the national income. It may indeed be fairly regarded as a permanent tax, since the ease with which it can be imposed and its elasticity make it a favourite and valuable source of revenue to all governments. The

Act of 1842, as subsequently amended by the Act of 1853, lays down the general principles on which the tax is imposed, and the subsequent Acts have been mainly modifications in detail as to exemptions, abatements, deductions, &c.

Everyone who has an income derived from property, profession, trade, or an office is chargeable, while in addition certain persons, such as guardians, trustees, or a husband for his wife, must also make returns of the income under their charge. In the same way, officers of a public company or employers may be required to furnish a list of their employees, with details of their income.

The income-tax year runs from 6th April of one year to 5th April in the next, both days inclusive. In the case of death, the income of the deceased is reckoned from the previous 6th of April down to date of death. The tax—as its name implies—is chargeable in respect only of annual income or profits, and for the purposes of collection the sources of income are grouped under five different heads, comprised in the Schedules A, B, C, D, and E. The tax is leviable only on the net income derived from all sources, and thus a loss under one schedule may be set off against the gains under another. Thus loss arising from occupation of land may be set off against the property tax, *i.e.* the gains derived from the ownership of land, and so on. In order to obtain this relief, notice of claim must be given within six months of the expiry of the year of assessment, *i.e.* before 5th October in that year.

1. Schedule A.—The tax under this schedule —sometimes called the Property Tax—is assessed on the annual return from land and house property, and is ultimately payable by the owner, although it is primarily recoverable from the occupier. Originally the assessment was on the full rent fixed, or if no rent had been fixed or if it was elusory, then at the full annual value. Now, however, an allowance is made for repair of buildings. If lands are let along with farmhouses and other buildings, there is an allowance of one-eighth for repairs, and the tax is only assessable on seven-eighths of the annual value. In the case of houses—exclusive of farmhouses—tax is payable only on five-sixths of the annual value, one-sixth being allowed for repairs. As the tax is only payable in respect of profits actually received, if property be actually unoccupied no tax is payable, but of course property occupied by the owner is profit-yielding, and liable to taxation on the annual value it would yield if let. Further, if a tenant fail to pay the year's rent or the whole of it, and it be lost to the landlord, he may reclaim the tax, if paid, proportionate to the rent lost. Further, relief may be claimed on account of temporary abatements from rent such as are not uncommonly made after seasons in which farmers have suffered loss through the inclemency of the weather. The claim for repayment must be made within twelve months of the expiration of the year of assessment.

The annual profits or returns from coal, tin, lead, iron, and other mines are also assessable under this schedule, according to rules under Schedule D, the profits being estimated on the basis of the average of the five years preceding the year of assessment. If, however, the annual return has decreased and is decreasing, so that the average of five years would not give a fair average, the year preceding the year of assessment may be taken as the basis of assessment, and if the mine has wholly failed the assessment may be discharged. Quarries of stone, slate, limestone or chalk are assessed on the basis of the profit for the year preceding the year of assessment, and the fact that the stone, slate, or chalk is obtained by underground and not by open workings does not make the quarry assessable as a mine. The returns from iron or gas works, railways, ferries, fishing, waterworks, canals, &c., are also assessed on the basis of the profits for the year preceding the year of assessment.

Except in the case of houses of a less annual value than £10, or let for less than one year, the tax is always imposed on the occupier, though if the landlord desire, he may by written request have the assessment made on him direct. The occupier is entitled to retain the tax paid from the next payment of rent, and should always do so, but the failure to do so will not bar his right to reclaim it if he makes his claim within *five* years of the time when the repayment ought to have been made. The tax may be deducted from feu duties, ground annuals, or other annual payments, but it may not be deducted from payment of a casualty, which must be paid in full.

2. Schedule B.—The tax under this schedule is in respect of profits derived from the *occupancy* of lands, and of houses occupied along with a farm. It is payable by the occupier or tenant, and it is under this schedule that farmers are usually taxed, though, as will be shown later, they may elect to be taxed under Schedule D. The tax is, in fact, on the estimated profits arising from the farming of the land. If the lessee of a farm has also the shooting rights under a separate lease, the tax will be imposed in respect of occupancy to the extent of the rent payable under the two leases combined. The tenant of a deer forest is assessable on the full rent paid, and not on the agricultural rents of the lands. The profits arising from the occupancy of land as nurseries or gardens for the sale of produce are assessable under Schedule D.

The profits assessable under this schedule are estimated to be one-third of the annual rental payable. Thus if a farmer pays £600 per annum of rent, the annual profits arising from his occupancy of the farm are taken at £200, and so on. (The exemptions and abatements will be explained later.) But a farmer may, as already mentioned, elect to be assessed under Schedule D if he thinks it is more favourable to him. Thus if the rent of the farm was £1200 per annum, and he has reason to believe that his average profits estimated on the basis of Schedule D fall short of £400 per annum, he may, by writing delivered before 5th June in any year, elect to be assessed under Schedule D. If the letter is sent through the post, it must be registered. The notice must be given annually. But even if a farmer do not elect to be taxed under Schedule D he is not without redress, for if he

can show within twelve months of the expiry of the year of assessment that his profits fell short of the sum on which he paid tax, he will be entitled to be repaid the tax overpaid. This being so, it is difficult to see what advantage there can be in electing to be assessed under the latter schedule, for, as will be explained presently, the average of three years' profits must be taken, and the form of appeal is more complicated. Under Schedule B, on the other hand, the farmer can in no event be asked to pay tax on a greater amount than one-third of his rent, and may pay on even less if he can prove his actual profits to have fallen below this amount. Thus he need never pay on more than his actual profits, and may pay on a good deal less. Of course it must be understood that if the farmer has other sources of revenue, the tax on these will be levied on the full annual income.

If, by reason of flood or tempest, loss shall be sustained to crops, or the lands rendered unfit for cultivation, then, if the tenant proves that the rent has been abated, the commissioners may abate the assessment to a proportionate extent. When the owner is himself the occupier, he may claim abatement on this ground. The assessments are as a whole only revised every five years, but where rents have been reduced or increased the assessment will be adjusted to suit the alteration.

As already pointed out, where the profits arising from the occupancy of land fall short of the sum on which tax has been paid, the farmer may claim abatement. This abatement is also allowed to owners occupying their own land for husbandry, even although they do not obtain their livelihood principally from farming.

3. Schedule C.—The tax under this schedule is on annuities, dividends, interest, &c., payable out of Government funds either in Great Britain or elsewhere, provided, of course, the profits are received in this country. When the annuity is payable out of the funds of this country or of any British colony, the tax is retained by the parties entrusted with payment; and similarly whose annuities from a foreign Government or the dividend or interest on stock of a foreign Government are paid in this country, the party entrusted with payment must first deduct the tax.

4. Schedule E.—As this schedule bears some resemblance to Schedule C, it is more convenient to refer to it now. The tax under this schedule is in respect of incomes derived from all public offices or employment of profit. Thus the salaries of all Government officials, civil servants, officers of the navy, army, &c., ministers of the State churches, salaries derived from county or municipal authorities, and the remuneration paid to directors or other officials of any public corporation are among the subjects of income taxable under this schedule. Where expense is necessarily incurred in the performance of the work, *e.g.* travelling expenses, a deduction may be made from the salary, but this will not apply to cover the travelling expenses of directors of a company going to meetings of the Board. In the same way, the amount paid to any deputy or *locum tenens*, or clerk, may also be deducted, provided it be expense 'necessarily incurred in the performance of his duty'. Where a minister had contributed out of his salary a sum towards the assistant's salary, it was held this was not a necessary expense and so not a good deduction.

5. Schedule D.—This schedule is the widest in its scope of all the schedules, and covers all profits or income derived from any source not included in the other four schedules. The only exception under this schedule is income which accrues abroad and is not brought into the United Kingdom. Thus a person permanently resident abroad will still be liable to pay tax on all profits derived from any property situate or business carried on in the United Kingdom, and anyone permanently resident here is liable to pay on profits derived from a foreign source if brought into this country. But officers and officials resident in India remitting money home for the uses of their families resident in this country are exempt.

For the purposes of the Income Tax Acts, residence means a stay in this country for a total period of six months in any one year; but a person who has a permanent residence is deemed to reside in this country even though he may not himself be in the country for six months in the year. Thus a sea captain with a house for his wife and family in Glasgow was held to be resident for the purposes of taxation, although as a matter of fact he was at sea for more than nine months in each year on the average. In the same way it has been held that the tenant of a shooting in Scotland, though a foreigner, and only resident here for the shooting season, is liable to assessment.

As already pointed out, farmers are as a rule assessable under Schedule B, but there is one case in which the Revenue may demand that they be assessed under this schedule. Where lands occupied by a cattle dealer or dairy farmer are proved not to be sufficient for the keep of the cattle brought on to them, so that the rent of such lands does not afford a just estimate of the dealer's profits, the Revenue officials may demand a return of the annual profits, and if they exceed the amount on which tax has been paid, under Schedule B they may impose the tax on the additional profit disclosed; and of course, in any event, farmers who derive income from any other source than the occupation of land must return these profits under the proper schedule.

The profits assessable under this schedule are to be estimated on the basis of the average profits for the three years preceding the year of assessment, or such shorter period as the business has been in existence. All disbursements necessarily made in the carrying on of the business may be deducted, but no deduction may be made for private purposes—*e.g.* the maintenance of the house or family. Thus rent of business premises, rates and taxes, salaries of employees, stationery, &c., may all be deducted.

Deduction is allowed of the premium paid on a policy of assurance effected on the life of the party assessed or that of his wife, provided the total premiums do not exceed one-sixth of the *total* income. This deduction may also be claimed from the assessment under Schedule A, B, or E.

But it is provided that such deduction shall not entitle any person to claim total exemption, if the deduction of premiums brings the total income below £160. So also, if the deduction brings the income below say £400 or £500, abatement cannot be claimed to the larger extent allowed when the total income falls under these amounts.

(1) Appeal.—The process of appeal against the tax is the same under whatever schedule the assessment is made, the only difference being that in the case of Schedule D the average of three years is taken, while under the other schedules each year stands by itself. Written notice of appeal must be given to the surveyor in terms of the intimation given on the notice of assessment, and a full statement of the total income must be given to the surveyor at least three days before the day of appeal. The appellant must appear in person before the commissioners, but he may be accompanied by his agent, who may state the case if the commissioners agree to this, but it is in their discretion whether they will allow this or not. If the appellant considers the decision of the commissioners erroneous on point of law, he may appeal to the High Court. There is no appeal on questions of fact.

(2) Reclaiming Tax.—Claims for repayment of tax on the ground that the person assessed is entitled to abatement or exemption may be made, subject to what has already been said, at any time within three years of the expiration of the year to which the claim refers, *i.e.* claims for the year ending 5th April, 1909, are competent up till 5th April, 1912. Where the total income in any year is less than £160, total exemption may be claimed and all tax paid—*e.g.* tax deducted from dividends, &c.—reclaimed. Where the income is over £160, the following abatements may be claimed, viz.:—

Income over	£160	and not over	£400,	abatement	£160.
,,	£400	,,	£500	,,	£150.
,,	£500	,,	£600	,,	£120.
,,	£600	,,	£700	,,	£70.

For Revenue purposes the incomes of husband and wife are reckoned as the husband's income; but if the combined incomes do not exceed £500 and that of the wife is derived from a separate business carried on by her, husband and wife are entitled to make separate returns, and to claim exemption or abatement according to the amount of their respective incomes.

Partners may be entitled to exemption or abatement although the total profits of the firm would not permit of this. Thus if two men carry on a business which shows a profit say of £300, which is divided equally between them, each partner would be entitled to exemption provided he had no other income. And so with abatement. In order to avoid the necessity for reclaiming tax paid by the firm, the partners may claim to be assessed separately, and in such case, if the surveyor is satisfied, effect will be given at once to the claim for exemption or abatement.

The Finance Act of 1907 introduced a further modification in the incidence of income tax by differentiating between earned and unearned income. The provision of the Act is as follows: 'Any individual who claims and proves that his total income from all sources does not exceed £2000, and that any part of that income is earned income, shall be entitled to such relief from income tax as will reduce the amount payable on the earned income to the amount which would be payable if the tax were charged on that income at the rate of 9*d*.'

Of course the tax is imposed annually, and the rate is subject to variation. [D. B.]

Incubation and Incubators.—If the poultry industry is to take its proper place as the most important of the minor branches of agriculture, the use of incubators becomes a necessity. The suggestion is not, however, to dispense with the brooding hen altogether, but only to make hatching possible at those times of the year when it is next to impossible to obtain sufficient hens as sitters.

The old plan of allowing a hen to nest in the roosting compartment of the poultry house is a bad one, as quietness is one of the essential factors towards obtaining the best results. Some quiet spot in a shed or outhouse should be chosen, sufficiently large to accommodate the number of birds sitting at a time. An earthen floor is preferable to either a wooden or cement one. The only necessary accessories are sitting boxes inside and feeding cages outside, and as simplicity in structure is an advantage, in this case the expense need not be great. Sitting boxes are better made in pairs, the double box being 30 in. long by 15 in. wide and 18 in. in height. A wire-netting bottom will prevent rats getting at the eggs. The top should be made loose so as to form a lid, through which the hens can be lifted off and on to the nest. A spadeful or two of damp earth should be put in the bottom of the box and hollowed out saucer-shape. The addition of some straw will then complete the nest. The feeding cages are usually made in sets of three, the set being 6 ft. long by 2 ft. wide. They are made floorless, and with the front fitted with laths of wood, through the spaces between which the hens can feed. The lid again is made movable. Dry ashes are put on the floor, and a trough for food and water placed in front. In this way the birds obtain a dustbath at the same time as they come out to feed. Sitting hens only require attention once a day, and the best results are obtained when this is given regularly each morning. As a test the hens should be placed in the boxes for a couple of days on dummy eggs; at night the nest eggs can be taken away and others set in their place. Once a day they should be lifted off the nest and placed in the feeding cages, and given hard corn, water, and grit. It is inadvisable to use soft food, as they are only fed once each day, therefore corn should always be employed. It is sometimes difficult to know exactly how long the eggs should be cooled, but the following times may be suggested: If the shed temperature is about 60° F. the hens can be left off for about half an hour; if lower, for a shorter period; and if warmer, for thirty-five to forty minutes will suffice. When the eggs commence

to hatch, the hens should not be disturbed for at least twenty-four hours.

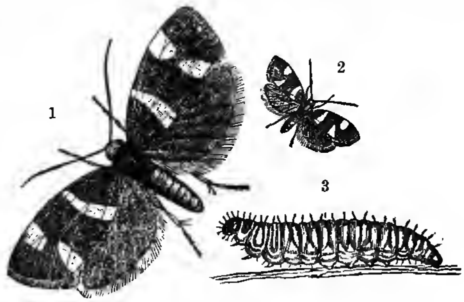
The object of artificial hatching is to provide a machine which will do the work of a hen, and therefore makers have followed as closely as possible the natural method, only adapting it to the altered circumstances. Incubators have reached a high state of efficiency, but undoubtedly there are many points on which improvement will have to be effected before they will become really perfect. The majority of machines are constructed so as to supply air laden with moisture to the embryos within the shells, and all are arranged so as to supply a regulated amount of heat. It is impossible to enter here into a full description of the various types of machines, but the following suggestions alone may be given. The amount of air required for the proper combustion of the oil supplied to the lamp is great, and moreover, the embryos need a considerable quantity of oxygen for their proper development, therefore the room in which the incubators are placed must be well ventilated. An even room-temperature is an advantage, so that the regulating apparatus may not be overstrained by sudden variations. In those machines which are directly ventilated, such as the hot-water tank type, the temperature of the egg drawer must be regulated according to the room temperature, and the scale given here has been found to produce the best results. With a room temperature of 45° F. the egg drawer should be 105° F.; room temperature 60° F., egg drawer 104° F.; and with a room temperature of 75° F. the egg drawer should register 103° F.

Incubators require rather more attention than sitting hens, but when it is taken into consideration that a larger number of eggs can be set at the same time, this difference does not amount to much. The lamp should be trimmed and filled each day, unless a self-filling lamp is employed. The eggs will want cooling twice a day; the time here depends, as in the case of the hen, on the heat of the room. In room air of 45° F., cool for fifteen minutes in the morning and ten minutes at night; in room air of 60° F., cool for twenty minutes in the morning and fifteen at night; and in room air of 75° F., cool for five minutes longer each time. When the eggs are hatching, leave the egg drawer closed as long as possible. With those machines fitted with the drying box below, only open once each day; and with those in which the drying box is above, open every six hours during the day, so as to take those chicks away which are sufficiently dry.

Whichever system is followed, the eggs should be tested on the sixth or seventh day for fertility. This is done by holding the eggs to a light in a darkened room, and noting the nature of the contents. If fertile, a spidery-like form will be seen rather above the centre of the egg. All infertile and addled eggs should be taken out at this time.

It is commonly believed that hen-hatched chickens are better than those hatched in a machine, and there is a certain amount of truth in this belief. Against this, however, we may place the fact that hens are not always available when required, and, therefore, for modern poultry-keeping the adoption of artificial means is a necessity. Every year sees improvements in this direction, and so there is every possibility that, in the future, incubators will be made which will be equal in all respects to hens for brooding purposes. Further improvements in incubators will consist in better ventilation and a more even supply of water vapour in the atmosphere of the egg drawer. See also art. Chickens, Rearing of. [W. Br.]

Incurvaria capitella (the Currant Shoot and Fruit Moth).—The caterpillars of this small moth are very mischievous in certain years, attacking the buds and feeding in the



Currant-shoot Moth (*Incurvaria capitella*)

1, Moth (magnified). 2, Moth (nat. size). 3, Caterpillar (magnified).

pith of both red and black currants, but especially in the first named. The moths appear towards the end of May and continue into June. They are about $\frac{5}{8}$ in. across the expanded wings. The front wings are brownish or fuscous with a satiny gloss, and a pale-yellow band across at about one-third of their length from the root, two pale-yellow patches about halfway between the yellow band and the tip of the wing; these two patches are respectively on the fore and hinder edges of the wing. The hind wings are grey. The moths fly by day, and may be found settled on the bushes. The females deposit their eggs in the young fruitlets, and there the young caterpillars feed for a while. Their presence can readily be detected by the green fruit turning prematurely red and shrivelling. Later, they creep from the fruitlets and spin a cocoon in the shelter of a piece of rind on the shoots, and there they remain hibernating all through the winter. In the spring they crawl forth again, and either enter the buds or bore right into the pith of the young shoots.

Their presence in spring is shown by the withering of the shoots and leaves. The larvæ are red, and easily seen inside the shoots on splitting them open. Later, they become a greenish colour, and when mature they turn to brown pupæ, which force their way out of the cocoons before the moths emerge. When in the currants the larvæ are only about $\frac{1}{12}$ in. long, and live inside the seeds. It appears that the female lays two eggs at each penetration of the fruitlets, and these minute bodies are nearly colourless and lemon-shaped.

Treatment.—It is advisable to have the plantations hand-picked in spring when the shoots show flagging, and burn them and the contained larvæ. Little else can be done, but some benefit may be derived by spraying in the winter with caustic wash, as it brings away the scales, &c., beneath which the little winter cocoons are found, and so exposes them more readily to tits and other birds which feed upon them. [F. V. T.]

India, Agriculture of.—India is mainly an agricultural country. In 1901, 196 million out of the 294 million inhabitants of India, or exactly two-thirds, were directly dependent upon agriculture. All the rural village communities subsist mainly, and in most cases entirely, from agriculture, and it has been estimated that about nine-tenths of the rural population live directly or indirectly by agriculture. The average holding varies from about ½ ac. in the congested parts of Bengal to 8 ac. in Madras, and more in the thinly populated parts of Burma and Assam; and in India proper the customary laws of inheritance tend to encourage continuous subdivision. The cultivators have usually little or no capital, and consequently often fall into the hands of money-lenders in time of scarcity; and even in ordinary years they have generally to borrow. Within recent years, and especially in congested districts like Lower Bengal and the Ganges valley, the number of landless labourers has largely increased, although plenty of cultivable land is available if only the people would migrate so as to be more evenly distributed.

The relative areas cropped and waste, or under forest, in the principal provinces of India (but excluding feudatory and tributary states, and areas for which no returns exist) during 1904 were as follows:—

Province.	Classification of Areas (in square miles).						
	Total Area.	Net Cropped Area.	Current Fallow.	Total Occupied Area.	Cultivable Waste other than Fallow.	Uncultivable Area (barren lands, buildings, waterways, &c.).	State Reserved and Protected Forests.
Madras	101,109	42,147	9,556	51,703	8,868	20,772	19,766
Bombay	115,383	42,661	17,545	60,206	12,485	30,369	12,323
Bengal and Eastern Bengal	152,453	76,454	10,573	87,027	19,470	37,746	8,210
Assam	28,894	7,730	1,980	9,710	12,258	3,148	3,778
United Provinces	103,971	55,799	3,206	59,005	16,928	13,556	14,482
Punjab	89,270	38,924	3,805	42,729	28,130	12,999	5,412
Burma	162,530	19,679	4,934	24,613	36,484	82,808	18,625
Central Provinces and Berar	96,710	38,611	5,131	43,742	23,747	8,256	20,965
N.-W. Frontier Province...	13,280	3,638	602	4,240	2,981	5,532	527
Total	863,600	325,643	57,332	382,975	161,351	215,186	104,088

As regards meteorology, India may be conveniently divided into three climatic regions: (1) Northern India, lying between the Himalayas and the Vindhya hill range; (2) Peninsular India, lying to the south of the Vindhyas; and (3) Chittagong and Burma, forming the north-western seaboard of Farther India.

Climate and Crops.—In India proper, two distinct crops are harvested—the autumn crop (*kharif*) and the spring crop (*rabi*); while the year has four definite seasons, determined by the temperature and the rainfall. From June to October the south-west monsoon usually brings an abundant rainfall to the greater part of India. During November and December the monsoon current changes, and some rain may then fall. January and February are cold, while March, April, and May are hot. The sowing of autumn crops (*kharif*), consisting mainly of wheat and rice, begins with the first rains in June and extends to July, and the resulting crops are reaped between September and December. The spring crops (*rabi*), consisting mainly of millets and other dry crops requiring less rain but benefiting greatly from dew, are generally sown in October and November, and reaped in March and April. Throughout all Western and Central India, and in the Ganges valley, the most critical time for the agriculturist is the south-west monsoon period, which practically determines the rainfall; while the south-east of the peninsula mainly receives its rainfall during the north-east monsoon.

Lower Bengal, Eastern Bengal, Assam, Burma, and the western seaboard of the Indian peninsula all receive a heavy rainfall of 70 to 100 in. or more, which constitutes them the chief rice-producing areas, and makes them comparatively free from scarcity caused by drought. Burma as a whole has copious, well-assured rainfall, although there is a central dry zone where scarcity sometimes occurs. Rice is the chief crop in all tracts having heavy rainfall, but jute is also grown in the delta of the Ganges and the Brahmaputra, and tea on the hills of Bengal and Assam. In tracts having only a scanty rainfall, and throughout the dry and arid tracts in Sind, Rajputana, and parts of the Punjab, Bombay, Madras, and Upper Burma, the water required for crop cultivation has to be supplied by irrigation canals from the great rivers (Indus, Jumna, Ganges, &c.), and from tanks and wells. But despite all these artificial supplies, by far the greater portion of India is subject to scarcity and famine, owing to having an average annual rainfall of only 30 in. or less.

The work of the cultivator (*rayat*) varies in quality from very good to very bad, according to circumstances. Where the soil is fertile, and the rainfall sufficient and favourably distributed, and where irrigation from wells is customary, the cultivation is excellent; and the hill slopes terraced by hardy hillmen are also well cultivated. But in districts without facilities for improvement, cultivation attains only a very low standard.

Soil.—Although in India there is much less geological variation as to soil than in Britain, yet there are so many varieties that they can only be here classified very briefly. Alluvial tracts, which form the most extensive and the most important agricultural soil, occupy the greater portion of Sind and northern Bombay, Rajputana, the Punjab, the United Provinces, the Bengals, the Godavari, Kistna, and Tanjore districts of Madras, and the valleys in Assam and Burma. Throughout the great Indo-Gangetic plain the surface soil varies in colour from light-fawn to brown, and in consistency from drift sand to undrainable stiff clay, which causes superficial salt accumulation through excessive evaporation under the hot sun. Where the soil is neither too sandy nor too clayey it is usually very fertile, owing to its great depth. The fertility of the Deccan trap, extending over 200,000 square miles, and covering most of the Bombay Presidency, all Berar, and the western parts of the Central Provinces and the Hyderabad State, varies greatly. Where alluvial, this soil may be 20 ft. deep, and is known as 'black cotton soil' (*regar*). This is extremely retentive of moisture, and becomes unworkable for some time after rain; and unless the soil is only moderately deep and with a subsoil permitting free drainage, irrigation cannot be practised. During the hot season, evaporation is intense and huge cracks form; hence the native saying that 'black soil ploughs itself'. The crystalline gneiss schists, &c., occurring throughout all the rest of the Indian peninsula where the surface soil is not alluvium or trap, and found over nearly all Madras, Mysore, the south-east Bombay, the eastern half of Hyderabad, the centre and east of the Central Provinces, and parts of Bengal, yield soil varying from unproductive and light-coloured up to yellow and brownish-red fertile loams and clays. All classes of Indian soil, however, are deficient in phosphoric acid, nitrogen, and organic matter.

Cultivation.—The few tillage implements used in India are of very simple construction, and there is little scope for introducing labour-saving appliances, as labour is plentiful and cheap. The plough is practically often the only implement in use. There are many kinds of plough, varying in weight and efficiency, but in all of them the part penetrating the soil is a wedge-shaped block of hard wood to which an iron share is usually attached; the draught pole projects in front, and the neck-yoke of the bullocks is attached to it, while a short single upright stilt behind serves as a guiding handle; the point of the wedge loosens the soil, while the body of the wedge moves the loosened soil but does not invert it; and the depth to which the wedge penetrates, according to the weight of the plough, varies from a few inches to a foot. Where heavy ploughs are necessary, iron turn-furrow ploughs have been largely introduced; but where light ploughs alone are required, the cost of an iron plough is against its adoption. Over the greater part of India a light plough is used for sowing seed, a bamboo tube being attached to it as a seed drill, and through this tube the seed is dropped by hand as the plough works. Throughout the Deccan the scarifier, unknown in upper India, is extensively used. It consists of an iron blade about 3 ft. long and 2½ to 4 in. wide, with a sharp cutting edge; the blade is fixed by wooden or iron stays to a horizontal beam forming the headpiece of the scarifier; and there is a draught pole with neck yoke, and a stilt or handle with which to guide. The blade cuts all weeds and produces a soil mulch, while the wooden headpiece in passing over the surface acts effectively as a clod crusher. A light scarifier is usually used behind the seed drill to cover the seed and level the surface. Seed drills are used in the same tracts as the scarifier. They have a stout wooden headpiece giving support and attachment to all other parts, the pole, yoke, and guiding handle being all secured as in the scarifier. Coulters are set obliquely at varying distances in the headpiece; a hole is drilled in each coulter, into which a bamboo tube is inserted, communicating with a perforation in the seed bowl, and both bowl and seed tubes are supported by ropes. The seed is dropped by hand into the bowl, and two men are required—one to drive the bullocks, and the other to fill the bowl with seed. The seed drills used for sowing spring crops on black soil are heavier than those used for autumn crops, so that in the absence of rain the seed may be deposited in a moist layer and germinate properly. Bullock hoes are constructed like the scarifier but on a smaller scale, the blade being from 7 to 15 in. long, according to the distance between the rows of the crop for which they are intended. Bullock hoes are worked in pairs driven by one pair of bullocks, but a man guides each implement so that the hoe cuts weeds and stirs the surface soil between the rows of the crop. A grubber or harrow consists of a three- or four-coultered seed drill without its bowls or bamboo tubes, and sometimes the tines are fixed closer together, and are made of hard wood up to 12 in. long and tipped with iron. Levellers and clod crushers, consisting of a rectangular beam of wood drawn by one or more pairs of bullocks, are used to smooth the surface before sowing, and to conserve the moisture—the driver usually standing on the leveller to make it heavier and more effective. In the different provinces carts vary greatly in size, construction, cost, and general utility; some are light and handy, others very cumbrous. The specific hand tools used also vary considerably in different provinces. In Madras, heavy soils are dug by a crowbar being inserted into the cracks and levered over; but the Indian spade is a sort of inturned hoe or mattock (like the common hand-hoe), consisting of an iron blade fitted to a wooden handle at an acute angle, and is worked

with the blade pointing inwards towards the labourer. The native pick is made from the forked branch of a hardwood tree, but owing to railway construction and other earth work, the English pick is now much in use. Sickles are in common use for reaping, and a good weeding hoe is made from worn-out sickles. After threshing, sieves of bamboo or grass, and riddles of various patterns, are used to separate the grain from the chaff when the wind is not strong enough for winnowing by the very simple plan, everywhere practised, of filling a scoop with the threshed material, holding it high up from a platform, and slowly allowing the contents to fall to the ground, so that the chaff may be blown away by the wind while the grain falls to the ground. The scoop is also used very deftly by women for cleansing the grain from lumps of earth and other impurities. Hand-mills or querns are employed for husking and grinding into meal the grain needed for daily domestic use.

Tillage has, so far as possible, to be done in the intervals between heavy rain. The land is ploughed whenever there is sufficient moisture to produce a layer of finely pulverized soil favourable for germination. As the poorest cultivators are usually much indebted to money-lenders, whose demands they can only meet by selling their best produce and leaving only inferior grain for the next season's seed, this fact unfortunately interferes greatly with the selection and interchange of good seed.

Irrigation is necessary over the greater part of India owing to insufficient and precarious rainfall, and during the last twenty-five years vast tracts in the Punjab, Sind, the United Provinces, Bengal, and Madras have been brought under irrigation by canals, which have now made these dry and arid zones, formerly little more than barren deserts, the most productive parts of India. The vast northern plains, through which the Indus and the Ganges and their tributaries flow, have proved very suitable for canal irrigation, and a large proportion of the lands thus rendered cultivable have been systematically dealt with. Such tracts are first divided into acre plots, and then subdivided into quarters. Distributing channels are laid off at regular intervals, and each piece of land receives its share of water. Vast areas are thus under flow irrigation, but much of the land is just about the canal level, so that the water has to be lifted slightly. But large alluvial areas are under irrigation from wells, towards the construction and improvement of which grants are made by Government; and this has resulted in a recent large increase in this class of irrigation. In Southern India the hitherto prevailing systems of irrigation by means of water storage in lakes and tanks are more difficult and costly. Large banks are there constructed by levelling and terracing catchment areas on poor land, rice being the chief crop grown on the highly farmed tank lands irrigated by the water passing down in steps from one field to another.

The Irrigation Commission of 1901–3 estimated that, exclusive of the large areas directly watered by river floods and the many thousands of acres artificially saturated by rain-water held up within field-embankments, the total area ordinarily irrigated in British India from all sources was as follows (the total cultivated area being then taken as 226,064,000 ac.):—

Source of Irrigation.	State Works.	Private Works.	Total Area.
	acres.	acres.	acres.
Canals	15,644,000	1,235,000	16,879,000
Wells	—	12,895,000	12,895,000
Tanks	2,944,000	5,194,000	8,138,000
Other sources	—	6,186,000	6,186,000
Total	18,588,000	25,510,000	44,098,000

Province.	Average Annual Cultivation.	Average Annual Irrigation.	Percentage of Irrigation on Whole Cultivated Area.
	acres.	acres.	
Punjab and N.-W. Frontier Province	28,207,000	10,430,000	37·0
Sind	3,323,000	2,923,000	88·0
Bombay Proper	24,327,000	1,077,000	4·4
Madras	36,574,000	10,532,000	28·8
Bengal	63,664,000	6,349,000	10·0
United Provinces	41,086,000	11,055,000	26·9
Ajmer-Merwāra	388,000	142,000	36·6
Baluchistan	(?)	5,000	—
Upper Burma	4,666,000	828,000	17·7
Central Provinces	16,814,000	700,000	4·2
Berar	6,820,000	56,000	0·8
Coorg	195,000	1,000	0·5
Total	226,064,000	44,098,000	19·5

Since then, however, several other large State irrigation works have been opened, and in 1906–7 the area irrigated from State canals was nearly 23,000,000 ac. The total capital outlay on these

works has been £33,000,000, yielding a profit of about 7¾ per cent, and raising crops of an annual value exceeding £35,000,000.

Next to an adequate water supply, manure is the chief need of Indian agriculture. As cattle dung forms almost the only fuel in the thickly populated tracts, where wood is scarce, there are vast areas where little or none of such natural manure enriches the soil; but much progress has of recent years been made in using the sewage and poudrette of large towns for agricultural purposes, and Amritsar, Karachi, Ahmedabad, Madras, Bombay, and Poona all possess sewage farms. If crude sewage be put directly on any but the very lightest land (such as that of the Karachi farm), the soil becomes slimy and crop-sick. Near Poona the clarified sewage from a series of septic tanks can be run on to the land as freely as irrigation water, and produces very large and profitable crops. At present, however, the conservation of cattle and goat manure is of far greater agricultural importance, though the cultivator has much to learn in this respect. In some of the highly cultivated districts, arrangements are made with graziers to fold their goats and sheep upon land about to be cropped; and where obtainable the leaves of trees are used as manure, especially on rice land. Green manuring with crops of san-hemp (*Crotalaria juncea*) and wild indigo is practised to a small extent, and the careful cultivator is not slow to adopt new means of providing manure, although artificial manures are only used on highly cultivated garden lands, such as tea and coffee estates. Bones are generally sold, and about 100,000 tons are annually exported.

Bare fallowing is effectively practised on some of the deep black cotton soils of Bombay; and in some thinly populated districts (as in Sind), where manure is very scarce, land may be fallowed two years in every three. The advantages of rotation are well known to the cultivators, and the growing of several crops simultaneously is a common practice, in order to obviate total loss during seasons proving unfavourable for any one particular crop. But throughout most of the forest tracts a very pernicious system of temporary and shifting cultivation (Jhim, Kumri, Taungya, &c.) has been customary from time immemorial, under which patches of the forest are cleared, burned, and cultivated (with rice chiefly), then abandoned for a fresh clearing in the following year, and so on, the hillmen not returning to the original clearance for ten or twenty years. This wasteful system is now being controlled and regulated by the Forest Department, so as to keep it within the narrowest possible limits consistent with the necessities of the hill tribesmen.

Crops.—The more important field crops, and their distribution in the different British provinces (for which alone accurate statistics are obtainable) in 1904, are shown in the following table (in square miles):—

Province.	Area (in square miles) under Principal Crops.									
	Rice.	Wheat.	Millets and Pulses.	Cotton.	Fodder Crops.	Sugar Cane.	Tobacco.	Indigo.	Poppy.	Tea.
Madras	12,955	39	25,034	2,765	373	86	226	409	—	19
Bombay	3,825	3,287	26,582	5,905	25	93	126	9	—	—
Bengal and Eastern Bengal	54,535	2,357	12,413	125	106	1008	840	390	335	212
Assam	6,188	16	157	6	57	63	7	—	—	528
United Provinces ...	9,435	12,210	26,895	1,306	1544	1703	81	220	689	13
Punjab	1,075	12,215	13,355	1,637	3330	517	84	84	14	16
Burma	14,542	53	2,517	249	40	20	100	1	—	3
Central Provinces and Berar ...	7,014	5,273	17,018	6,495	430	30	50	—	—	—
North-West Frontier Province	51	1,411	815	48	80	43	10	—	—	—
Total	109,600	36,861	124,786	18,536	5985	3563	1524	1113	1038	791

Rice (*Oryza sativa*) has been cultivated from time immemorial, and is the staple food of the greater portion of the people throughout all the moist tracts (the coast districts and Burma) having a damp, tropical or subtropical climate. The most extensive rice cultivation takes place, and the finest kinds are grown and the heaviest crops are produced, in damp, warm tracts with heavy, well-assured rainfall, where the sunshine is not extremely intense during the growing season. The cultivated varieties of paddy (unhusked rice) are very numerous, and differ greatly in quality; and the cultivators understand how to utilize best for each kind the local conditions of soil, water supply, and climate. Most of the finer kinds of paddy are grown from transplanted seedlings, and have long, thin, sharp-pointed yellow grains. The husked rice is long, thin, translucent, and nearly white, the finest varieties being also somewhat scented. The coarser varieties generally yield large, full-bodied, deep-scored, dark-coloured grains, and the husked rice is usually thick, opaque, and ranging from white to reddish-brown in colour. In some parts of Madras three rice crops are taken in the year on canal-irrigated lands fertilized by silt, while in Bengal two crops (the *aus* in spring, and the *aman* in autumn) are usually taken; but in most of the other rice tracts of India only one crop is taken annually, and usually in autumn, although a pulse crop is also often grown in the same year. Rice is always

grown on level inundated fields, the water being enclosed by low banks (*bund*). Rice grows best on a good clayey loam. It is an exhausting crop, and needs manuring with cattle dung, tank mud, and tree leaves, although green manuring is also practised. Rice fields may be either sown (broadcast or in drills), or planted with transplants from a nursery where seed has been sown broadcast. Planting is the commonest, best, and most economical method, as 30 to 80 lb. of seed will furnish plants enough for 1 ac., whereas 80 to 120 lb. have to be used in sowing broadcast. The highly cultivated nurseries are often manured. In parts of Bombay the practice of *rab* cultivation prevails, which consists of spreading cow dung, brushwood, dry leaves, and coarse grass over the seedbed, and burning them to enrich the soil. In the nursery the seed is sown thick enough to furnish transplants for six to ten times as large an area. In about six weeks the seedlings are 8 to 10 in. high, and are ready for transplanting into the liquid mud of the rice field that has been ploughed and puddled while inundated with water. The plants are put into the soil in wisps of about four plants stuck into the soft mud at from 6 to 12 in. apart. If the water has not drained off naturally before that time, it should be allowed to run off while the ears of grain are ripening, so that the fields should dry for about ten or twelve days before the crop ripens in September (early kinds) or in November and December (late kinds).

The crop is cut with a sickle, and laid in sheaf-like bundles, which dry in a few days; then the sheaves are tied together and carried to the threshing floor, to be trodden by buffaloes or bullocks, or to be beaten out. The yield varies up to about 2400 lb., or over 1 ton per acre. Although very large quantities of rice are consumed in India, there is a large export trade, from Burma chiefly (where it now amounts to over 2,000,000 tons annually). See also Rice.

Wheat of three species is commonly grown — *Triticum vulgare*, *T. spelta*, and *T. pilosum*, but chiefly *T. vulgare* and its varieties—and the grain yielded by most varieties is square-headed and fully awned. Wheat is always a cold-weather crop, and is chiefly cultivated in Northern India, where the area annually under crop depends greatly on the rainfall immediately preceding field operations, because little rain falls during the period of growth. Indian wheats are classified as white, yellow, and red, and each such class is subdivided into hard and soft varieties. In the best varieties the grains are long, elliptical, fairly well filled, and heavy. While wheat is grown as a dry-season crop, linseed, pulse (*gram*), safflower, and spring millet (*jowár*) are the chief crops grown in rotation with it during each year. Good cultivators pay great attention to preparing the land for wheat, but it is usually little manured. Sown in October, the wheat crop ripens in three and a half to four and a half months. The seed is either drilled or broadcasted, from 60 to 100 lb. per acre being sown; and the return from a good average crop is about 800 lb. per acre. On the irrigated plains, wheat is a most important crop, as it grows well on the alluvial loams watered by the great canals. In tracts where the rainfall suffices, preparatory tillage takes place for some months before sowing; but in dry districts, where wheat can only be grown with irrigation, the land is usually given one good watering shortly before the sowing, so as to make it ploughable and produce a good seedbed; and a second watering is given just before sowing, to supply sufficient moisture for germination. After being sown, the land is smoothed by roller, and divided into compartments for irrigation. Experience has shown that four waterings during the period of growth produces the best results. Great mistakes are often made by cultivators new to irrigation, as they are apt to drown the crop by too frequent watering. Wheat is reaped by sickle or uprooted by hand, and then threshed out by the treading of cattle. Mixed with peas (*gram*) the chaff makes good fodder. A good crop of irrigated wheat may also yield 1200 to 1600 lb. of pulse (*gram*), but rust often does great damage. Except during time of famine, large quantities of wheat are exported, the exports of recent years exceeding about 2,000,000 tons.

Indian *Millets* and *Pulses* are of two types—'great millets' (*Jowar*, *Bajri*), with large leaves and stout stalks, which grow to about 6 to 8 ft. high, and 'small millets', not exceeding 3 ft. high; but the great millets are much more important cereals than the small millets.

The Great Millet, or *Jowar* (*Sorghum vulgare*), is chiefly an autumn crop, though occasionally grown in spring. There are many varieties, some early and some late in ripening; but the length and the thickness of the stalk, and the size and quality of the grain-head, depend greatly on the season, the soil, and the cultivation. The weight of a head ranges up to 1 lb., while the shape varies from a hard, densely packed cone to a many-branching drooping panicle, and the colour from pure-white (giving the best grain) to dull-brown. Besides being one of the staple food crops of the people, it is the most important fodder crop over a large part of India, and yields up to about 13 tons of green fodder per acre, or 5 tons when dry. It grows best where the rainfall is 30 to 40 in. (where it is often sown in rotation with cotton), one variety (*jowar*) being usually grown on strong soil, and another (*bajri*) on thin light soil. *Jowar* requires a fine friable seedbed, which should be ready for sowing by the end of June. On black soil much of the preparatory tillage is done with the scarifier during the hot weather and the early rains, and without manuring; but various pulses, oilseeds, and fibre plants are often grown in admixture with it, at the rate of 6–8 lb. of jowar and 2½ lb. of pulse or other seeds, the mixed seeds being drilled at 14–16 in. between the rows, and weeding and hoeing being afterwards necessary. The *Jowar*, the main crop, ripens in October or November, and is then cut with a sickle, while the subordinate crops may be harvested as they may happen to ripen either before or after that. After the reaping, the heads of grain are removed and threshed by the treading of cattle, while the stalks are stacked for fodder. A good crop yields about

900 lb. of grain and 200 lb. of subordinate crops per acre. Among the subordinate pulse crops, *Gram* (*Cicer arietinum*) may be taken as a typical specimen. It is a low-growing feathery plant, usually with small pink flowers, but there are four kinds, differing mainly in the colour of their seeds, varying from white through red and yellow to black. *Gram* is always a spring crop, and is largely grown as a pure crop on black soil. On heavier alluvial soil it grows well without irrigation, and is then sometimes mixed with wheat or barley; and a good crop of *gram*, being dense and low-growing, leaves the land clean and enriched in nitrogen. *Gram* receives the same sort of preparatory tillage as wheat, but should be the first of the spring crops to be sown, as it requires a warm, moist seed-bed. Its growth is much influenced by winter rains in January; and it is harvested on ripening between February and April, and yields up to 800 lb. of grain per acre, the largest outturn being obtained by nipping back the main shoots before the plants flower.

Cotton (*Gossypium*) has been an Indian crop since very ancient times. Several kinds are now cultivated, and much attention is being paid by Government to the improvement of cotton crops. Of the indigenous cottons (most of which produce lint that spins 20 to 40 counts) some mature in five months, and others take eight months, the latter passing through several months without rain, and therefore requiring a deep soil with moisture in the lower layers. The percentage of lint varies from 25 to 40, the inferior yield being mainly due to impoverished soil and neglect. The kinds maturing in five months are most numerous, and produce very short pure-white lint, much of which is valuable for mixing with wool. The plants are usually tall, slender, and individually not productive, and the inferior kinds, being less liable to fail, are usually more profitable than the others. Indian cotton has deteriorated within recent years, probably owing to the use of bad seed obtained from the factories. The only exotic cottons as yet successfully acclimatized are Bourbon in Madras, Upland Georgian in the south of Bombay, and Egyptian in Sind; and even these are not thoroughly successful, as diseases and insects do more damage to exotic than to indigenous cottons. The deep 'black cotton soil' is the best for cotton, which is there usually grown alone or in lines with *arhar* (*Cajanus indicus*) or *jowar*, although *jowar* and cotton often form a two-course rotation in some parts. The best cotton cultivation is in Broach, where the land is prepared all through the hot weather, and the seed is drilled in rows 20 in. apart, at a rate of 10–15 lb. per acre, after being treated with a mixture of cow dung, mud, and water owing to the fuzz upon the seeds; and careful hoeing is given while the crop is growing. The plants begin to flower in October, and picking lasts from November to March, four or five pickings being necessary as the crop gradually ripens; and good soil gives an average yield of 400 lb. of seed and lint per acre. The export of raw cotton amounts to about 300,000 tons annually, and the largest quantities usually go to Japan and Germany. See also COTTON.

The *fodder crops* are mostly millets (see p. 117 above).

Sugar cane (*Saccharum officinale*) of two kinds is grown, with numerous varieties. In the one kind the cane is thick, juicy, and exhausting, and in the other it is thin and non-juicy. The canes vary in colour, appearance, and quality, and the most suitable soil is a good firm loam or a light clay; but when irrigated, the crop grows well on any kind of soil having good drainage. It occupies the land for ten to eleven months, and a second crop (*ratoon*) is often taken from the root-stocks. Planting begins in February, and should be completed before the hot weather. The crop needs high cultivation, and is generally propagated from sets 6 to 12 in. long, and containing several eyes, planted every 6 in. in rows 2 ft. apart, on land laid out in beds for the irrigation given immediately after planting. Much hoeing is necessary, and the canes should be earthed up as they grow. As sugar cane grows slowly in the first three or four months, subordinate quick-growing crops, such as maize, onions, and cucumbers, are sometimes sown with it. It is difficult to tell when the sugar cane is ripe, and a trial boiling is often necessary for this purpose. When ripe, the canes are either uprooted, or else cut with a sharp sickle to give an after-crop (*ratoon*). The canes were formerly crushed by wooden or stone mills, but the juice is now usually expressed by iron mills and then concentrated by boiling in a large pan. In Northern India a fair crop yields 20 tons of cane per acre, giving 1½ to 2 tons of crude sugar (*gûr*); but in the south, under high farming the ordinary yield averages about 3 tons of *gûr* per acre. Both the internal and the export trade in refined sugar have diminished greatly, owing to the fiscal laws enforced by Britain, which admit of the free importation of bounty-fed beet sugar.

Among *Oilseeds* the most valuable crop for export, although only holding third place in point of area, is the *Linseed* (*Linum usitatissimum*), grown chiefly for its oil-producing seed and the oilcake valuable as cattle food, because efforts to extract fibre have as yet been unsuccessful. A mature crop is from 1½ to 2 ft. high, with stems branching freely in the upper parts. The acreage under linseed largely depends on local food requirements, the European market, and the relative value of cotton and linseed for the time being. It is only sown as a spring crop on deep moist soil, and is usually grown pure (except in parts of Bengal and the United Provinces, where it is mixed with wheat, rape seed, and spring pulses), and unless grown on rice land it is the only crop of the year. From 10 to 12 lb. of seed per acre are drilled into the well-prepared friable soil in September–October, and only lightly covered. Very little rain is required on land moist enough to secure good germination. The crop is precarious, and 500 lb. per acre is a good yield. *Sesamum* (*Sesamum indicum*), yielding 'Gingelly oil', is an annual herbaceous plant of 3 to 4 ft. high, bearing numerous oval, flattened seeds varying from

white through red to black. It forms both an autumn and a spring crop, with special varieties suited to different local conditions. As a spring crop on black soil it is grown alternately with cotton and *jowar*, which clean the land thoroughly. The small seed, mixed with ashes or fine earth to secure even distribution, is either sown broadcast, or else drilled in rows 12 to 18 in. apart. If sown in September it ripens in January; but if sown as an autumn crop (usually mixed with cotton, *jowar*, or *bajri*) it ripens in October or November. It is best harvested by uprooting the plants and shaking them over a cloth to collect the seed. The crop is uncertain aud liable to many mishaps, and 450 lb. per acre is a good average yield. The seed is now mostly exported, and not merely the oil, so that Indian agriculture loses the advantages of the oilcake for cattle feeding and manure.

Jute (*Corchorus*) of two kinds (*C. capsularis* and *C. olitorius*) is cultivated, and chiefly the former. In both kinds the stems of each are green or red, the green stems yielding the better fibre. Jute production is almost entirely limited to the rich alluvial stretches along river banks and the fertile swamp lands forming the delta of the Ganges and the Brahmaputra; and the Bengals provide the bulk of the raw jute required throughout the world. The exports of raw jute amount to about 700,000 tons a year, and the chief importing countries were Britain, Germany, and the United States. But vast quantities are manufactured locally in the Calcutta jute-mills. Jute is chiefly cultivated on land liable to inundation when the plants have made some growth; for it is an exhausting crop on soil not enriched by river-borne silt. The conditions that suit rice also suit jute, and the soil should be clean, well manured, brought to a fine tilth, and should for seed germination have about the same moisture as is required for ordinary dry crops. From 8 to 12 lb. of seed per acre are sown broadcast in April or May. After the plants appear, they are thinned and weeded; but when the crop has established itself, further weeding is unnecessary. It grows to 11 ft. high, and should be harvested before fully ripe, the stalks being cut near the ground and tied into bundles. Stacked on end in the field in a close round heap for a few days, these bundles are usually entirely submerged in waterholes, a pernicious practice impairing the quality of the fibre. Retting is completed in about twenty-one days, the fibre being separated by washing and beating. The value of jute fibre depends on its colour, lustre, strength, length, and fineness, and on the absence of roots; and a good crop should yield 2500 lb. of clean fibre per acre. (See JUTE.)

Tobacco of two kinds (*Nicotiana Tabacum* and *N. rustica*) is cultivated, but chiefly the former, which grows to from 5 to 7 ft. high. The best crops are obtained on river alluvium and on a clayey loam, and where well-irrigation furnishes water containing potassium nitrate. The crop is raised by transplanting seedlings from a carefully prepared and heavily manured seed-bed sheltered from heavy rain and intense sunlight, a bed 15 by 10 ft. supplying seedlings enough for planting an acre. The seed is sown in July or August, and when 4 or 5 in. high the seedlings are planted out during cloudy weather at 20 by 20 in. apart. Hoeing and weeding are constantly needed, and when the plant has reached a fair height the stem is topped to drive the sap into the ten or twelve remaining leaves, and all suckers are removed. Till it ripens in February or May, the crop may be watered every fortnight, and it is ready for cutting when the leaves become brittle, crumpled, and spotted. In Bombay the leaves only are stripped, but elsewhere the whole plant is usually cut; and the after-treatment depends upon whether black for hookah-smoking, or yellow tobacco for cigar making, &c., is to be manufactured. Yellow tobacco is prepared by irrigating the land two days before cutting the crop, and spreading the leaves on the ground for eight days before tying them into bundles to mature slowly and be only slightly fermented, when it turns yellow-brown and is ready for sale. An ordinary crop of tobacco yields from 1200 to 1500 lb. of cured leaf per acre. (See also TOBACCO.)

Opium (*Papaver somniferum*) grows to a height of 2 to 4 ft., the kind commonly cultivated on heavy loam or light clay in the Gangetic plain being that with white flowers. About 3 lb. of seed per acre are sown broadcast in October or November on well-tilled and manured beds prepared for irrigation, and the crop is thinned out till the seedlings are 8 to 10 in. apart. Frequent weeding and hoeing are needed, and the crop is subject to many injuries from frost, rain, cloudy weather, and east winds. The poppies are ready to yield opium when the capsules turn light-brown and harden slightly. Then they are scarified deeply, but in one part only, with a three-bladed instrument in the evening, and next morning the gummy juice (crude opium) exuding from the cuts is collected and stored in earthen jars till the whole of the opium obtainable has been gathered by making fresh scarifications on different parts of the capsule for five or eight times, at intervals of two days. An average crop yields about 20 lb. of crude opium per acre and about 250 lb. of seed (see also OPIUM).

Indigo was formerly chiefly obtained from *Indigofera sumatrana*; but of recent years Natal indigo (*I. arrecta*), and another kind known as Java-Natal, have been considered more likely to maintain the once important Bihar and Tirhoot indigo industry against the increasing competition of the synthetic substitute. Many of the indigo planters, however, are already devoting a large portion of their estates to the growth of sugar cane, and the indigo growing is no longer so important as it once was. (See INDIGO.)

Besides the field crops above mentioned, there are also garden crops, such as the climbing-vine-like *Pepper* (*Piper nigrum*), extensively cultivated in Southern India (see PEPPER); *Tea* (*Camellia theifera*), forming a very important industry in Assam and throughout Northern India along the base of the Himalayas (see TEA); *Coffee* (*Coffea arabica*), on the highlands of Southern India (see COFFEE); and *Cinchona*, in parts

with an altitude of 4500 to 6000 ft., and a rainfall of from 50 to 100 in. a year (see CINCHONA).

Vegetables of many kinds are grown as garden crops for household use and for sale in towns, their extensive cultivation being mostly carried on by special castes. English vegetables of good quality are chiefly grown near large cities with the aid of manure obtained from town sweepings and sewage. The vegetables mostly grown are cabbages of different kinds: turnips and radishes, pulses and beans, gourds and cucumbers, potatoes and yams, brinjal, tomatoes, beet, spinach, onion, garlic, roselle, &c.

Fruits of many kinds are cultivated, including all kinds indigenous to temperate (Himalayan), subtropical, and tropical climates. The most important of all is the *Mango* (*Mangifera indica*), the fruit of a large tree everywhere cultivated in groves or topes and gardens; but the finest mangoes are those grown in Malda, Bombay, Multan, and Mandalay.

In good fruiting seasons (May and June) mangoes form the chief food of the poorer classes for several weeks in many parts of upper India. The common kinds are easily grown from seed, but the fine kinds are all grafted and are carefully cultivated. The succulent fruits of the *Mahwa* tree (*Bassia latifolia*) in Central India also form a valuable food supply, as well as the waxy yellowish flowers appearing in April, which are eaten both raw and cooked, and are used in distilling spirits, while a good oil is expressed from the seeds.

The more important of the many other kinds of fruit include the custard apples, pummelo or shaddock, and many other kinds of oranges and limes, for which Nagpur and Sylhet are famous. The guava, papaya, melons of many kinds, jackfruit, banana, pineapple, and cocoanut, tamarind, the almond, peach, strawberry, loquat, apple and pear, all thrive high up in the hills, and some kinds even succeed on the plains. Many of the hill tribes subsist partially on wild fruits of the forest, and these form an important food supply in time of scarcity and famine.

AGRICULTURAL LIVE STOCK consists mostly of buffaloes in the rice tracts with heavy rainfall (those of Lower Burma being the finest breed), and of oxen and goats in all the drier parts, horses, camels (in Punjab and Sind chiefly) and sheep being less important. The finest breeds for draught purposes are the big, heavy Hansi (Punjab) and the white cattle of Guzerat; the Nellore (Madras), for slow and heavy work; the Amritmahal (Mysore), for rapid roadwork with light loads, and the white-and-grey Malvi (Central India and the Deccan); while the best cows for milking are the Montgomery (Punjab), the Gir breed (Kathiawar), and those of Sind. Since 1890 considerable improvements have been made in dairying; but owing to frequent scarcity of fodder, and promiscuous breeding through non-castration of inferior bulls, there is as yet but little improvement in stock-breeding. In each province, however, there is now a veterinary department, and dispensaries with travelling inspectors to inoculate against cattle-diseases and segregate infected animals, and to work the bull-breeding farms with which Government is trying to effect improvement. As hay is not made, cattle often suffer severely during time of scarcity and famine. Goats of very indistinct breeds are reared indiscriminately for the supplies of food and milk they give. Horses are mostly imported, many being needed for the Indian army. To increase the number of native horses suitable for remounts, mares branded and registered by the veterinary department are covered free of charge by Government Arab and thoroughbred English or Australian sires, and prizes are given at the annual horse fairs. Mules are also largely bred for military transport.

The chief *agricultural improvements* effected by Government have been the vast irrigation schemes throughout all the dry zones in Northern, Central, and Southern India, and Upper Burma, which can be watered by canals from the great river systems. But Government loans are readily obtainable for agricultural improvement, £180,000 being set aside annually for this purpose.

Agricultural affairs throughout India are administered by the Department of Land Revenue and Agriculture, with an Inspector-General of Agriculture as chief technical adviser to the Government of India, and also to the Provincial Governments; while each province has a civilian Director of Agriculture controlling a provincial staff of agricultural experts, who meet annually, and form a Board of Agriculture for discussing important pending questions and submitting recommendations thereon to Government.

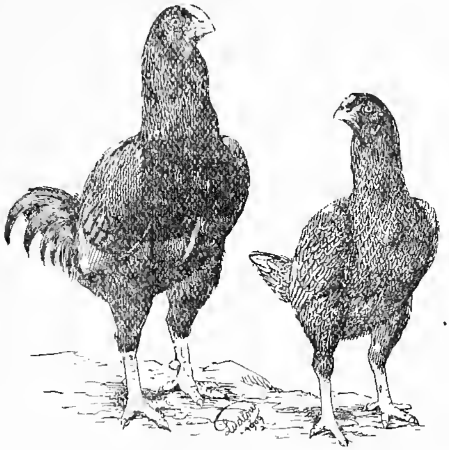
Agricultural experiments and research are being conducted by eighteen imperial and forty-one provincial experts, who have mostly been appointed within the last ten years; while *agricultural education* is being given in one Imperial and seven provincial agricultural colleges, each having a small European staff and native assistants. But as Indian agriculturists are mostly illiterate, the teaching has to be chiefly of a very elementary character. [J. M.] [T. E. M.] [J. N.]

Indian Corn. See MAIZE.

Indian Game Fowl.—The Indian Game, whilst carrying a large amount of flesh upon the breast, does not conform to the standard laid down for table poultry, in that it is very heavy in bone and has flesh which, although well distributed, is hard. Weight of bone means slow growth, and that is always a disadvantage. The birds are also very yellow in the legs and flesh, and in the majority of our markets would not be accepted for that reason. It has a broad, prominent, and deep breast, with very muscular and heavy thighs. The legs and neck are long, and, as already indicated, the bone is strong and abundant. The head is broad and the beak stout, the comb being pea-shaped and very small. These birds are large, and frequently adult males will scale at 12 lb., and hens 6 to 8 lb. They are attractive birds, carrying themselves very upright.

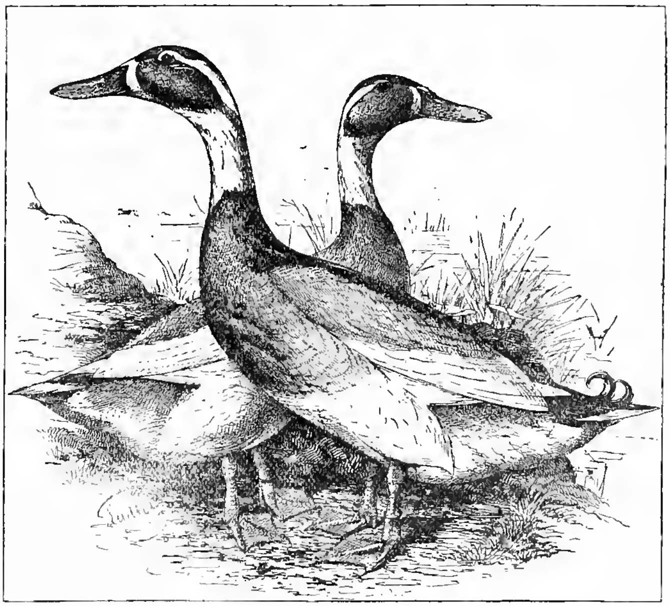
The hens are poor layers, although the eggs are very deep in tint of shell and rich in quality. It is, however, not for egg production that this breed is kept, but for their table qualities, which, in spite of what has been stated above, are con-

siderable. These birds are vigorous, and when crossed with softer-fleshed races, using an Indian Game male, the chickens produced are large and



Indian Game Fowl

very fleshy, but are better suited for the autumn than for the spring trade, as they do not grow quite fast enough to meet the requirements of the latter. At one time the Indian Game Dorking cross was greatly advocated, and there is no doubt that for autumn birds it is a very valuable one; but as the chickens do not grow fast it is not suitable for production of early birds. Other crosses are with the Buff Orpington or the Faverolles, both of which can be recommended. The chickens as a rule are hardy; but it may be pointed out that, in spite of the vigour of these birds, pure Indian Game fowls do not thrive well on damp soils, and therefore they are generally kept upon higher ground, where the natural drainage is sufficient. It is an interesting fact, emphasized by what has been said as to this breed, that for the production of table poultry a cross between a hard and soft fleshed race yields some of the best results, and in that direction the Indian Game has rendered very great service. [E. B.]



Indian Runner Ducks

Indian Meal. See MAIZE MEAL.

Indian Runner Duck.—This breed has attained a large measure of popularity in some parts of Britain and Ireland, not by reason of its flesh qualities, but as an excellent layer. As the eggs are ordinarily about the size of hens' eggs, they really command better prices than the huge eggs produced by other duck breeds. The Indian Runner would appear to have been introduced into West Cumberland by a ship captain about the middle of last century. The carriage of this duck is peculiar; with head and neck outstretched they run along the ground very rapidly, and hence their name. Ducks of that type are to be met with in nearly all countries. Unfortunately the breed has been modified unduly for exhibition purposes, both as to shape and colour of plumage. There are now several colours, but in all the head is marked with white, the throat and neck are white, and also the wing flights, whilst the rest of the body may be either fawn or grey. In size they are small, ranging from $3\frac{1}{2}$ to $4\frac{1}{2}$ lb., even when fully grown, and consequently are not of much use for sale as ducklings, although the flesh is very fine in quality. But it is as egg producers that the Indian Runners have found favour, and in this direction they are indeed remarkable both as young and as old birds. They are practically non-sitters, and splendid foragers, finding the greater portion of their food, so that, where a free range can be given them, they cost very little to keep. This is an important point owing to the fact that, as a rule, ducks are heavy eaters, and upon good pasture these birds will keep themselves almost entirely. They wander pretty widely, but return home without any seeking on the part of the poultry keeper. [E. B.]

Indigestion.—When one remembers that the principal object of the farmer is the conversion of vegetable into animal substances, the importance of preventing and of curing indigestion in animals will be fully realized. Indigestion in the very young is one of the first troubles of the breeder. Good or bad assimilation of food practically determines his profit or loss in rear-

ing and in milk production throughout the period of maturity, and settles the question of utility or retention in the stud, the herd, and the flock when age advances. The indigestion of the newborn or very young is treated under the heading SCOUR. The causes as a rule are unsuitable food, or food given in proportion or in condition difficult of assimilation, or at too long intervals, or in excessive quantity after being long withheld. The food may be suitable, yet the changes from dry to green or from the pasture to the stable or byre may be too sudden, and the animal fails to digest and assimilate a ration he would profit by, if the transition had been gradual. It has been proved by the most elaborate experiments upon dogs that the gastric and peptic glands (and presumably those of the other organs besides the stomach engaged in digestion) produce their respective solvents in proportion to the food anticipated. While mastication is proceeding in the mouth, instructions are sent down to the stomach, so to speak, as to what to expect and prepare for; but adequate preparation cannot be made at a moment's notice for an entirely different kind of food when habit has been established. The most successful feeders recognized this before vivisection of dogs had proved that an excess of acid is produced where a diet of meat is expected, and that a larger proportion of peptones and alkaline fluids is prepared for a farinaceous meal. It is therefore important that changes should be made gradually, or art introduced to prepare the digestion for a new diet. In illustration of this, we may point to the old practice of giving an aloetic ball to horses before turning out, and again when taking in from grass. This custom facilitates the change in the gastric secretions, and enables the animal to deal more profitably with the new food. It is essential to digestion that enough water should be obtained, and at suitable intervals, otherwise the glands fail to contribute their quota in the mouth, where digestion begins, and later in the stomach and intestines. Watering of horses before feeding is now recognized as correct in principle, and less productive of gripes, which is itself a form of indigestion (see arts. COLIC, IMPACTION, GASTRITIS, STOMACH STAGGERS, &c.). Economic conditions may compel us to feed upon certain substances not altogether desirable; but in our efforts to combat indigestion we should give more consideration to hygiene than to curative medicines, which are but temporary aids, and seek a balanced ration, or change the conditions where animals are not thriving because of indigestion. It should be remembered that with regard to ruminants, and to horses only in less degree, a certain amount of distension is necessary to digestion, although we may be giving plenty of nutritious but concentrated food. During the hay famine of the last century, many bullocks were lost through feeding to excess upon maize, which was cheap, and withholding hay, which was dear. The opposite condition of extreme distension by innutritious and woody fibre has been particularly mentioned in connection with the stomach staggers of mountain and moorland ponies and other animals compelled to pick up a scant living on poor hillsides.

A great source of loss to the stock-raiser and horse-keeper is the indigestion caused by the presence of parasites in the stomach and intestines, as well as in the liver and other organs, whereby the powers are reduced and the products stolen—in many cases after the labour of digestion, and when almost ready to enter the circulation of the host. Indigestion may arise from failure of the liver, the pancreas, or other organs to produce in quantity and quality the necessary ferments and solvents which assist in the complicated process of digestion; or the food may be imperfectly dealt with in the mouth and not properly insalivated, owing to bad teeth or injuries to the tongue or membranes. The symptoms of indigestion are many, and among them may be mentioned hidebound and staring coat, dullness, loss of condition, inappetence, constipation or diarrhœa, ill-smelling breath, clammy or pasty mouth, high-coloured urine or excessive in quantity and of pale colour, arching of the back, grinding of the teeth, and grunting at the end of each expiration. It will be seen from the many causes of indigestion that a comprehensive review of the circumstances — the feeding, labour, and general conditions—should be taken, and the cause, if possible, discovered and removed. In the majority of cases it will be good practice to begin with an aperient suited to the species, age, and condition of the patient, and follow this up with such substances as sodium and potassium bicarbonates with calumba, or with the mineral acids and gentian with nux vomica; dilute phosphoric and nitro-hydrochloric acids often giving good results. Idiosyncrasies must be studied, and a diet that is found to suit the herd generally may not be digested properly by the individual, whose special requirements must be considered. It will sometimes be found that a horse will never settle down to the digestion of 'hard tack', but will thrive on grass, and roots and hay in winter, and that a beast will be habitually blown unless an oily portion is given in his food; and it may prove more profitable to dispose of such individuals to persons able to utilize them in different circumstances.

[H. L.]

Indigo may be described as a dye prepared by a special process of breaking up in water a substance obtained from the leaves and shoots of several widely different plants. Of these the following may be specially mentioned, in their order of importance: (1) Indian indigo, obtained from several species of *Indigofera* (Leguminosæ); (2) Assam, Burma, and Central Chinese indigo or *Rum*, from *Strobilanthes flaccidifolius* (Acanthaceæ); (3) the indigo of Northern China, Japan, and Siberia, from *Polygonum tinctorium* (Polygonaceæ); (4) European indigo (*Woad*), and that of Central Asia, Afghanistan, &c., from *Isatis tinctoria* (Cruciferæ); (5) the indigo of Nigeria, Egypt, and of Rajputana, from several species of *Tephrosia* (Leguminosæ); (6) the indigo of West Africa (Yoruba), from *Lonchocarpus cyanescens* (Leguminosæ); (7) the indigo of Cochin-China, from *Spilanthes tinctorium* (Compositæ); (8) the Nerium or Pala indigo of

South India, from *Wrightia tinctoria* (Apocynaceæ); (9) the *Ryom* or indigo of Sikkim, Northern Burma, and the Circars, from *Marsdenia tinctoria* (Asclepiadaceæ); and (10) an indigo of Burma, from *Gymnema tingens* (Asclepiadaceæ). The first mentioned (*Indigofera* spp.) is the indigo of modern European commerce, but it may be said Nos. 2, 3, 4, 5, and 6 are also fairly extensively grown, and afford the indigoes of the regions indicated. The others (7, 8, 9, and 10), and that list might be still further increased, are plants known to afford blue dyes (or indigoes) which are not utilized to any appreciable extent.

History.—Were a detailed history of indigo written, it would reveal the following among other rather striking circumstances: first, that the production of the dye has shifted from one part of the globe to another, every now and again, in response to political rather than industrial necessities; second, that similarly the species of plant used has been repeatedly changed; and third, that the methods of manufacture have drifted from what has been called the dry to the wet process. But it may be said (and with much truth) that the prospects of the natural or agricultural production have never been so alarmingly threatened as by the recent discovery that the dye can be profitably produced artificially in the chemical laboratory. Amid all these vicissitudes, however, the chemical nature of the substance desired and the rationale of its utilizations in the tinctorial arts, have remained practically unchanged for many centuries. The world has found no sufficient substitute, and still demands a continuous supply of indigo as it did in prehistoric times. The issues that engage attention at present may be said accordingly to centre around the endeavour to cheapen and at the same time improve the pigment, whether produced from the field or in the laboratory. Speaking of the agricultural interests, with which we are here more especially concerned, these are attained by the critical study of the species and race of plant grown, with a view to discover the best and most economical stock; by improvements in the methods of cultivation, so as to obtain the maximum yield from each class of soil; by the introduction of paying subsidiary crops, so as to lessen the cost of production; and lastly, by perfecting the methods of manufacture. Hopes are entertained that even if the natural indigo can never recover completely lost ground, there may still be room for an improved and cheapened article. It is, moreover, claimed that the natural dye possesses certain characteristics not as yet attained by the synthetic article. But, on the other hand, since the chemically produced pigment contains a higher percentage of pure indigo, it has an advantage over the natural dye in all countries where an import due is charged on gross weight. This point is, however, being faced by the chemists who are investigating the natural dye, and it is even anticipated that a chemically pure indigo is not impossible that will, pound for pound, hold its own with the best artificial dye.

Cultivation.—The practical effect of the disturbance caused through the discovery of artificial indigo may be demonstrated by the official returns of production. In 1892–3 the area in all India devoted to the crop was 1,218,766 ac., and the yield 179,056 cwt.; in 1894–5 the corresponding figures were 1,688,042 ac. and 237,494 cwt.; in 1896–7 they were 1,608,901 ac. and 168,673 cwt.; in 1898–9, 1,010,318 ac. and 139,320 cwt.; 1900–1, 990,375 ac. and 148,029 cwt.; in 1902–3, 645,511 ac. and 79,207 cwt.; in 1904–5, 476,900 ac. and 58,900 cwt.; and in 1906–7, 452,800 ac. and 69,700 cwt. The province in which indigo attains its greatest specialization is Bengal, more particularly Bihar, the chief

Indigo (*Indigofera tinctoria*).

districts being Champaran, Muzaffarpur, Darbhanga, and Saran. A fair amount is also grown in Madras, and smaller quantities in the United Provinces, the Punjab, and Bombay. It may suffice, therefore, to indicate the conditions and methods that prevail in Bengal. The land is prepared for the crop at the close of the rains in October, and the number of ploughings and harrowings depend largely on the nature of the soil. On the high sandy loams few ploughings may suffice, while many may be deemed necessary on low-lying clays. Indigo is sown at the commencement of the hot season, viz. February–March. The seed is drill-sown, and an abnormally large quantity used, namely, from 20 to 40 lb. to the acre. The total rainfall from November to May may be under 3 in. The planter is therefore entirely dependent on the moisture retained in the subsoil for the germination of the seed and the nourishment of the seedlings until the break of the rains in June. It is the aim accordingly of the tillage pursued, to pro-

duce a compact surface that may facilitate the capillary rise of water to the position of the seedlings. Throughout this stage the land is kept scrupulously clean, and though the growth is slow during the hot months, the plants shoot up with marvellous rapidity after the first few showers toward the middle of June. Naturally the low-lying lands first come into season, and must be reaped when the plants begin to flower, and as rapidly as possible, since the rise of inundation water might ruin the crop by washing the dye out of the leaves. Two cuttings are normally obtained, and known as the *morhan* (July–August) and the *khunti* (September). The shoots are hand-reaped, loaded on to bullock carts at once, and despatched as rapidly as possible to the factory. After the *morhan* crop the land is ploughed, so as to facilitate the absorption of water, and shortly after the plants shoot forth once again vigorously. On the removal of the ensuing *khunti* supply of shoots, the land is prepared either for some other *rabi* (spring) crop or for a fresh sowing of indigo. This is the *wet* method; but in Madras the plants are reaped, then conveyed to the farmer's house, where they are dried, and the leaves thereafter beaten from the twigs. This is the *dry* process. The leaves may thus be stored until a convenient season, when their contained dye may be extracted by a process very similar to that pursued with the wet (fresh) plant. The yield may be expressed as 57 cwt. per acre for the *morhan* cutting and 25 cwt. for the *khunti*, while the dye afforded may average 16 lb. an acre for the year—these would be the results in good cultivation.

MANUFACTURE.—Water is an essential, and therefore the factory is usually placed on the highest part of the estate where a liberal supply is attainable and easy discharge also possible. The plant on arrival at the factory is at once loaded into a large steeping vat, 20 ft. square and 5 ft. deep. When full the plant is battened down by beams acting on the side of the vat, then submerged, when steeping and fermentation are allowed to proceed from 12 to 14 hours. A yellowish-green fluid is thus obtained, and allowed to run off into a corresponding and attached lower vat, where it is beaten in order to cause its oxidation. In modern factories this is accomplished by machinery, replacing the manual labour of former times, and in certain factories the same object is attained by blowing a mixture of air and steam through the liquid, or still more recently by forcing ammonia into it. After oxidation the liquid is allowed to rest until the indigo is precipitated—*mal*—and the clear supernatant fluid—*maila-pani*—can be drained off by a series of taps opening at different levels on the side of the beating vat. The *mal* is then pumped into boilers, where it is mixed with clean water and boiled either by direct heat or by steam until it attains a certain consistence. It is then poured on to specially prepared tables or shallow troughs covered by cloth. The contained water drains away through the cloth, and the thickened paste thus obtained is then compressed into cakes 3 to 3½ in. in thickness, and shortly after cut by wires into cubes and stamped with the trade mark of the factory. These are next removed and assorted on shelves, to dry slowly and regularly in an airy room. In this condition they are ready to be packed and despatched. The refuse of the factory is returned to the fields, and is regarded as the most valuable of all manures for indigo lands.

TRADE.—The bulk of the factory-made indigo is exported, India itself using up only the inferior grades, as also the crudely manufactured article of the small native factories. From the returns of area and production, already furnished, it will be seen that the highest record occurred in 1894 (viz. a production of 237,494 cwt., of which 166,308 cwt. were exported, valued at £987,000). And the following year (which used up the surplus of 1894 as well as the supply of 1895) the exports were valued at £1,245,129. Since these dates the decline has been most significant, and paralleled by the expansion of the demand for the artificial product. In 1875 Great Britain took 72,494 cwt. of Indian indigo; in 1895–6, 66,215 cwt.; in 1898–9 (the year after the successful production of the synthetic dye) the demand was only 30,973 cwt.; in 1904–5 a further shrinkage took place, namely to 10,743 cwt.; and in 1906–7 to 7942 cwt.[1] Similarly, India's traffic with Germany, France, the United States, and Japan in the dye has fallen off seriously. Egypt might be said to be the only country that has maintained her demand; it has, in fact, for years past been the chief foreign market for the Madras dry-process dye, and of the cheapest indigoes. The imports of natural indigo into Great Britain during three years (according to British returns) have been valued as follows: 1905, £116,902; 1906, £111,445; and 1907, £151,297. Of synthetic indigo (mainly from the Netherlands): 1905, £121,269; 1906, £147,325; and 1907, £158,481. [G. W.]

Infants, Milk for.—The problem of feeding infants artificially becomes of increasing national importance. The gradual decline in the birth-rate and the maintenance of high rates of infantile mortality demand that infant life should be conserved. That there is a large preventable waste of infant lives is shown by the fact that the death-rate within the first year of life of 1000 infants born was in England and Wales in 1900 not less than 154 per 1000, the same exactly as it was in 1851–60; whereas the general death-rate for all causes at all ages has fallen from 22·2 per 1000 of population in 1851–60 to 18·2 in 1900. Infantile mortality is highest in manufacturing counties where mothers are employed, and lowest in rural counties. In textile manufacturing towns, the mortality figure rises as high as 170 to 195 per 1000. The chief circumstances which determine artificial feeding are—(*a*) occupation of mothers after child-bearing, and (*b*) unfitness of mothers for nursing. It is to be feared that wilful abstinence from that maternal duty is on the increase. Enquiries into the numbers of infants who die, and the causes of their deaths relative

[1] The differences observable between Indian and British official statistics are due to the year in the former terminating 31st March and in the latter 31st December.

to the source of their food supply, show unmistakably that infants who are fed artificially die in larger numbers than those who are breast-fed, and that the commonest causes of death are gastro-intestinal disorders, of which vomiting and diarrhœa are prominent symptoms. Epidemic diarrhœa is apt to prevail among infants during the warmer months of the year, and it is invariably found on enquiry that four times as many infants who are fed on cow's milk, and over six times as many fed on condensed milk, die, compared with those fed naturally. To overcome such mortalities, not a few municipalities have instituted milk depots wherein humanized or modified milk is prepared and sold for the use of infants deprived of Nature's supply (see HUMANIZED MILK).

The principal faults in connection with the artificial feeding of infants are mainly two in number, viz.: (1) improper kinds of food, and (2) overfeeding. To these may be added another, (3), uncleanliness of vessels and feeding bottles. The most available substitute for mother's milk, although a relatively poor one, is the milk of the cow modified as has been described. Since one of the dangers of cow's milk even so modified is the contained micro-organisms of fermentation and, it may be, of disease, obtained at the time of milking, during transit, or storage in dairy or at home, some form of heating the milk has to be adopted in order to destroy such microbes and enable the milk to be taken by the infant without risk, as well as to preserve the milk longer. In all municipal supplies the milk is either pasteurized or sterilized. Heating, however, changes the character of milk. Prolonged heating at a high temperature destroys certain natural ferments in the milk, and diminishes the citric acid (of which cow's milk contains from one to three times as much as woman's milk), which is thrown out of solution as a deposit of citrate of lime. Boiling kills all living cells in milk, coagulates the albumins, caramelizes the milk sugar, changes the fat both physically and chemically, and imparts a new odour and a new taste. In view of these changes by heat, it has been recommended that the temperature of pasteurization should never exceed 140° F. The only advantage of pasteurizing milk is that it destroys both fermentative and disease-producing microbes. This is of great value. The main disadvantage is that infants brought up on such milk are apt to develop scurvy or rickets. Buddeised milk would seem from experiments made by us to be microbe-free, and to be but little altered by its treatment. It has proved of value in feeding infants. To effectually sterilize milk requires exposure to boiling-point or over for a lengthy time, and causes a profound change in the milk.

To regulate the feeding of infants, it is not enough to prepare the proper strength of the milk suitable to the age, but to arrange also the amount suitable to the infant's gastric capacity. In municipal depots suitable mixtures are prepared, and sufficient only for one meal is placed in a separate bottle. A typical arrangement is the following:—

STRENGTHS AND QUANTITIES. FOR 24 HOURS' USE.

Mixture 1—				
At birth and for 10 days	= 9	bottles	each of	$1\frac{1}{2}$ oz.
For the next month	= 9	,,	,,	$2\frac{1}{2}$,,
Up till 3 months	= 9	,,	,,	3 ,,
Mixture 2—				
At 3 months	= 8	,,	,,	4 ,,
At 4 ,,	= 7	,,	,,	$4\frac{1}{2}$,,
At 5 ,,	= 7	,,	,,	5 ,,
Mixture 3—				
At 6 months	= 6	,,	,,	6 ,,
At 8 ,,	= 6	,,	,,	7 ,,

Before use, each bottle, still stoppered, is placed in a basin of hot water to warm its contents; the stopper is then removed and is replaced by a teat, thus avoiding indiarubber tubing, which is so apt to become foul from imperfect cleansing.

In Copenhagen, the strengths and quantities differ little from the foregoing. They employ four mixtures—the first three as above, the fourth consisting of 3 parts milk to 1 part water. Of mixture 1, for youngest infants, 10 bottles are given, each containing 135 grm.; of mixture 2, for infants of the earlier months, 9 bottles, each containing 150 grm.; of mixture 3, for infants of later months, 8 bottles, each containing 175 grm.; and of mixture 4, for infants of still later months, 8 bottles, each containing 180 grm. In some French establishments the bottles are of three sizes only, viz.: (1) containing 60 grm.; (2) 100 grm.; and (3) 150 grm. In all these arrangements it is intended to prevent overfeeding by supplying a separate meal in each bottle.

Condensed milks are much employed, among the poorer classes particularly. Such are sold in two forms, viz. the sweetened form, that is milk to which cane sugar has been added during the process of condensation; and the unsweetened form. Both are necessarily sterile owing to the temperatures of condensation, and keep for a long time in the air-tight cans. They are liable to microbic contamination, however, after the cans are opened, especially if not stored in clean places. Of the two forms the latter is the preferable, since the requisite amount of sugar may be added when the supply for the infant is being made. A word of warning must be expressed against the use of condensed *separated* milks for feeding infants, since they are practically devoid of fat, and infants fed thereon are apt to be starved. Condensed *whole* milks contain from 8·3 to 11·37 per cent of fat, unsweetened kinds contain between 10 and 12 per cent of milk sugar, and the sweetened kinds about 50 per cent of combined cane and milk sugars.

PATENT FOODS.—There are many of these on the market. Most, if not all, contain starchy material, which has either been malted and the starchy matter converted into soluble maltose, or by other processes into dextrose, which the infant stomach can digest and absorb. With regard to the use of farinaceous or starchy foods generally for infants, it has to be pointed out that at birth, and practically for at least the first ten months of life, owing to the inaction of

the salivary glands and the absence of ptyalin, infants cannot digest these readily. They may, however, be added to infant food when infants have attained about the tenth month of life.

Reviewing the whole question, it appears to us that infants deprived of their natural food should be fed on cow's milk modified as described by us under HUMANIZED MILK, the pasteurization of which may be achieved at home by the use of one of the many pasteurizing apparatus on the market, such, for example, as the Aymard, the Cambridge Sentinel, the Hawksley, the Soxhlet, or others, the chief point at all times being absolute cleanliness of preparation vessels and of feeding bottles, the teat of which should fit directly on the neck of the feeding bottle without the intervention of rubber tubing, and the storage of the milk for infant use in stoppered bottles. [J. GI.]

Infectious Diseases. — An infectious disease is one that can be conveyed from man or animal to other members of the community or to other animals, either belonging to the same species or a different species. From time immemorial it has been known that certain diseases were transferable from the diseased to the healthy, and in many cases the older observers believed in the theory that there was 'something in the air' whereby the maladies were communicated; in other words, that infection took place. The science of bacteriology was then unknown; but now that there are appliances for rendering the obscure and invisible visible, the study of micro-organisms, not only in relation to disease, but to the various sciences, constitutes one of the most important courses of the science student's curriculum.

Contagious diseases are those reproduced by contact; but it is better to avoid the usage of the term 'contagious', substituting 'infective', as this satisfies the whole of the methods by which these maladies are transmitted from the infected to the previously healthy subject. Moreover, some diseases are capable of being reproduced not only by direct contact, but also by indirect means, *e.g.* smallpox in man. It has been proved beyond all question of doubt that all infective diseases are due to the presence of minute organisms either circulating in the blood or manufacturing toxic material at the seat of injury (*e.g.* the bacilli of tetanus or lockjaw), the poison then circulating in the blood. The germs of nearly all these diseases can be cultivated outside the animal body on suitable media and at a proper temperature.

Not all infective diseases are due to bacteria, bacilli, micrococci, &c., but some are due to a class of extremely simple forms of animal life, known as the protozoa. Tsetse-fly disease, malaria, surra, mal de caderas, and red-water in cattle, and sleeping sickness, are caused by trypanosomes infesting the blood cells. It is rather a singular fact that these living organisms inhabit the interior of the white blood cells (giant cells), and can be demonstrated in their interior.

Certain species of flies act as the carriers of these disease-producing organisms. The mosquito and the tsetse fly afford good examples of the bearers of such parasites.

Cattle ticks carry the infusorians that cause red-water in cattle, also the so-called tick fever.

Tapeworms may be transmitted by fleas and dog lice, in fact the commonest tapeworm (*Tænia cucumerina*), infesting the dog, has its larval form resident in these pests.

All infective diseases have what is called a period of incubation, *i.e.* the time elapsing between the introduction of the poisonous material and the onset of the premonitory symptoms, the earliest warning of which is frequently afforded by the clinical thermometer, as most of these diseases have accompanying fever.

A distinction must be made between the 'period of incubation' and the 'period of infection', the latter meaning the period in which the patient is capable of infecting others. It may be as well to mention some of these periods in relation to the human subject first of all. In measles the period of incubation is about 11 days, and the period of infection one month; scarlatina 1 to 7 days for incubation, and power to re-infect 6 to 9 weeks; in diphtheria the 'latent' period is 2 or 3 days, and the period of infection 2 to 8 weeks.

In animals the principal infective diseases are: Foot-and-mouth disease, cattle plague, influenza, tuberculosis, red-water, epizootic lymphangitis, glanders, rabies, anthrax, contagious lung fever, cow-pox, sheep-pox, swine fever, actinomycosis and its allied forms botryomycosis and discomycosis, tetanus, nagana, surra, strangles, distemper in the dog, &c.

When the infective diseases of animals are compared to those affecting man, it must be admitted that the former are much less amenable to treatment; in fact the hopeless nature of some of these maladies calls for immediate notification to the Local Authority (Contagious Diseases Animals Act), to be dealt with according to the regulations in force.

In the human subject, some diseases, such as measles, scarlet fever, chicken-pox, &c., do, after the patient has passed through one attack, confer a degree of immunity against succeeding ones, though such 'protection' is not always absolute, but stands on a par with the protection afforded by a previous attack of distemper in the dog, and strangles in the horse, both of which—like measles in man—are specially prone to attack the young.

The virus of infective diseases is often spoken of as being 'fixed' or 'volatile'. Although rather ambiguous when used in connection with the perpetuation of disease, the former means that the *materia morbi* is incapable of being conveyed *through the medium of the atmosphere*, whereas the latter may be disseminated through this medium. Take, for instance, anthrax. The virus in this deadly malady is *fixed*, and the disease can only be reproduced by inoculation — through a wound, abrasion, &c. — with a particle of fresh blood, dried spores, or a cultivation of the organisms, or else through the digestive tract.

Anthrax-stricken cattle, horses, sheep, &c., cannot communicate the disease to healthy animals confined in the same atmosphere. Influenza and distemper are probably communicated through

the air, appliances, food, &c. In tuberculosis the poison is *volatile*, and infected cattle inhabiting the same cattle house as healthy ones can, in the writer's opinion, infect healthy cattle. Contagious lung fever is probably of the same nature. In rabies the virus is *fixed*, and precisely the same remarks are applicable to tetanus, actinomycosis, &c. A great deal of investigation is requisite in order to determine the methods of reproduction in infective diseases. The clothing of man and animals, drinking vessels and feeding troughs, food, water, stable appliances, bedding, birds, rodents, &c., constitute some of the principal media for the transmission of infective maladies. See also Hygiene of the Farm, and as regards the laws bearing on diseases of stock see Diseases of Animals Acts and Public Health Acts. [F. T. B.]

Infertility in Soils.—Infertile soils include those soils which, through some cause or other, are only capable of feebly supporting plant life, or, as in some cases, of preventing it altogether. Infertility may arise from a variety of causes, some of which are incurable, whilst others are remedial. In enumerating the causes from which infertility in soils arises, it must not be forgotten that this property, broadly speaking, is relative and not absolute, for the conditions of plant growth are variable, and moreover one set of conditions may be admirably adapted to one species of plants whilst fatal to the existence of another. To instance extreme cases, one might compare the conditions of growth of marine, marshy, and chalky plants. With such cases as these in mind it would be difficult, and inadvisable for our present purpose, to attempt to summarize the factors causing infertility in all classes of soils, and for all species of plants. Happily the condition of growth of the ordinary agricultural plants does not differ fundamentally but only in degree, so that in arriving at the causes definitely producing barrenness in agricultural soils, a study first of the general conditions included under the term 'fertility' would be helpful. The essential conditions of growth for all agricultural crops may be stated as follows: (1) Sufficient supplies of plant food, mineral and nitrogenous; (2) air; (3) a plentiful water supply; (4) suitable temperature; (5) suitable mechanical texture of the soil; (6) absence of injurious substances.

With these general conditions present in a soil, fertility is assured, and it naturally follows that in absence of any one of them infertility will result. In the British Isles, cases of absolute sterility in soils rarely exist, though of course abundant examples of poor and barren soils occur, of little use for the practice of intensive agriculture, but generally suitable, however, for the less important branches of agricultural pursuits. The causes producing barrenness may be summarized as follows:—

(1) Absence of one or more of the essential plant foods. (2) Absence of chalk. (3) Sourness. (4) Scarcity or excess of water. (5) Want of proper aeration of roots. (6) Toxic action of some salts and decomposition products. (7) Presence of excessive amounts of alkaline salts. (8) Scarcity of soil bacteria.

Taking these conditions in detail it is necessary to consider how they act, how they may be remedied, and which are the most common causes of infertility in soils.

Absence of one or more of the Essential Plant Foods.—Almost every soil contains in some form of chemical combination all the mineral foods necessary for growth. The essential mineral foods are: Phosphorus, potassium, calcium, sulphur, iron and magnesium, including nitrogen. The following, although found in plant ash, are not absolutely necessary: Silicon, chlorine, sodium, and manganese. The factor which determines the degree of fertility of a soil in respect to plant food is not the total quantity of plant food present, but the amount that is soluble in soil water or by the solvent action of plant rootlets. It so happens that many soils contain ample supplies of phosphates, potash, and nitrogen along with the other necessary constituents, yet they can only support a meagre vegetation, the reason being that either one or more of these essential foods are not present in sufficient quantities, in a soluble form, for the requirements of a vigorous plant growth. This form of sterility, provided other conditions of plant life are fulfilled, can obviously be made good by the addition of the deficient foods in the form of artificial manures. It is in this connection that the problems of economic manuring attain to an equality with those in other sciences. It is, however, almost impossible to arrive at that stage when the ideal food conditions of a plant growing in a soil can be measured and supplied, until more is known of the exact nature of the intricate changes and influences affecting the growth of plants in soils. Several methods can be adopted for estimating relatively the amounts of phosphates and potash available at any given time in a soil to a crop, and when the sterility of a soil is caused by a deficiency of available plant food, then it is a factor which can be determined and means taken to remedy it. In this connection it should be borne in mind that the use which a plant can make of the different foods available in a soil is regulated by that food which is present in least quantity. Thus, supposing in a soil there was abundance of all plant foods except the supply of available nitrogen, until sufficient nitrogen for all purposes was supplied, the plant could not use to the best advantage the plentiful supplies of the other available foods. This statement is known as Liebig's law of minimum, and applies in the same sense to all the plant foods. Nitrogen among all the plant foods is, in its available condition, subject to greatest fluctuation, on account of: (*a*) its method of liberation being a biological process; (*b*) the ease with which it is washed out of soils by drainage water.

Absence of Chalk.—The function which chalk plays in a soil is so varied that its absence, perhaps more than any other factor, accounts most for the presence of infertile soils in the British Isles. Bacterial activity is intimately connected with the conditions which the presence of chalk supplies. Absence or deficiency of chalk or magnesium carbonate in soils would retard nitrifi-

cation, and consequently reduce the supplies of nitrate to a minimum; it would encourage the accumulation of organic matter, and the tendency to sourness in the surface soil, &c. Any one of these results alone would account for infertility in agricultural soils.

Sourness, as mentioned above, is encouraged by the absence of chalk, and is likewise prevented by the presence of sufficient chalk. Some systems of manuring, particularly the frequent use of ammonium salts and superphosphate, slowly exhaust the chalk, and in time, unless added as a manure, a deficiency of chalk may ultimately result in producing sourness and infertility. Sourness arises also through ineffective drainage of the surplus water, and the conditions encouraged are adverse to the growth of useful soil bacteria; in fact, the conditions producing sourness are in themselves generally sufficient to account for infertility. Peat soils, unless well provided with chalk, have a tendency to become acid through the products of organic acids.

Scarcity or Excess of Water.—Water is just as essentially a vital factor in plant growth as the foods already enumerated. Plants take up their mineral foods in very weak solutions of soil water, hence without ample water supplies the necessary quantities of mineral constituents would not be forthcoming. Rainwater as it percolates, or spring water as it rises by capillary action, slowly attacks and dissolves the reserves of soil phosphates and potash salts, forming the weak solution from which plants assimilate their mineral foods.

The presence of excessive quantities of water, such as occurs in water-logged soils, renders the soil conditions adverse to the growth of agricultural plants, and results in infertility. On the other hand, scarcity of water, such as occurs in coarse loose gravels and sandy soils, likewise results in conditions equally unsuitable for the growth of agricultural crops. Provided other factors are not wanting, drainage in time restores the injury produced by stagnant water, and the introduction of humus by green manuring or by frequent applications of farmyard manure improves in time the retentive powers of sandy soils for water, and thus helps to ward off the infertility from this cause. Absence of sufficient plant foods may in sandy soils be one of the factors causing infertility in such soils. In arid climates the deposition of salts of the alkali metals on the surface soil, through evaporation of the surface water, results in the formation of the infertile alkali soils. Such conditions are, however, foreign to the British Isles, but are prevalent in India, America, Egypt, and Australia.

Want of Sufficient Aeration.—This is largely determined by the physical nature of the soil. When the texture is close and fine-grained, produced by too large a proportion of fine-grained particles, such as commonly occurs in clays, the conditions are generally adverse to healthy plant development. Unless the plant rootlets can readily penetrate the soil and get supplies of air, an infertile condition soon develops. Temperature, oxidation of soil constituents, water supply, and bacterial activity are all influenced, in fact determined, by the soil texture.

Toxic Action of some Substances.—In absence of sufficient chalk, the presence of much soluble magnesium salts exerts a toxic action upon plant rootlets. Carbonates of potash and soda likewise, when present in excessive amounts, produce similar effects. The effect of these latter substances is well instanced in the alkali soil mentioned above, where absolute sterility prevails so far as agricultural plants are concerned. The sterile condition of the nitre beds in Chile is another similar instance. Under certain soil conditions similar to those mentioned under 'Sourness' and 'Aeration', decomposition products arising from the decay of organic matter by anaerobic organisms may, if allowed to accumulate in the soil, produce harmful effects upon growing crops. Addition of chalk and efficient drainage are helpful in ameliorating these conditions. Many plants are said to secrete toxic substances, but further information upon the nature, durability, and specific effects is desired. The presence of unoxidized iron compounds,—sulphides, &c.—taken along with the conditions favourable to their existence, results in infertility. If the conditions are altered and improved the harmful compounds will likewise disappear. Salts of many metals and antiseptic substances, when added to plants growing in soil, cause harmful effects upon their growth. This may be due to some direct action of these substances upon the plant, or to their harmful action upon the soil bacteria associated with the changes involved in the formation of available plant food. Many subsoils when freshly ploughed up contain unoxidized compounds which inhibit plant growth; these effects, however, generally disappear after exposure to air. Pans formed of gravel cemented into hard masses with iron or chalk occasionally occur just below the surface soil—in fact, below the level at which the plough runs. These interfere with the supply of water at the surface through capillary action, and thus act in a harmful manner.

Scarcity of Soil Bacteria.—Wherever there is abundance of soil organisms it may be said at once that the conditions would be suitable for cultivation. In their absence it may be said with equal truth that there are one or several conditions present which are adverse to their existence, and equally adverse to the wellbeing of agricultural crops. [R. A. B.]

Infertility of Animals. See Barrenness, Fecundity and Fertility, and Sterility.

Infield.—In earlier times the agricultural land in Scotland was usually regarded as falling under one or other of three divisions: (1) croft or infield; (2) outfield; and (3) pasture. The infield or croft land was that immediately surrounding the mansion or farm steading, on which all the dung raised on the farm was bestowed, and which was regularly cropped. The outfield land was that which lay at a greater distance from the farm steading, and was used mainly for feeding cattle, though crops of oats were occasionally taken from it, and then the land was rested or left as ley. The pasture land was ground never ploughed, and frequently held in

common. The improvement in husbandry has completely altered the conditions to which these terms applied, and in more recent times consideration of the terms has been confined to questions in connection with the designation of grass glebes in parishes where there was not arable land available. See GLEBE. [D. B.]

Inflammation.—Inflammation has been variously defined, and may be destructive or reparatory. The object of medical or surgical treatment is to prevent or control it. In its simplest form, and when affecting an external part, it is characterized by heat, pain, swelling, and redness; but the latter sign is often invisible under the hairy or woolly coverings of the integument of animals. It is accompanied by the escape of some of the constituents of the blood into the parts affected. Its effects differ, therefore, according to the organ or parts affected. Inflammation of some of the muscles of locomotion, for instance, will cause lameness and inconvenience, but a corresponding degree of inflammation of the heart, liver, kidney, or other vital organ will so affect its functions as to cause serious illness, and perhaps death. The actual processes which occur during inflammation have been studied in the web of the frog's foot exposed to microscopic inspection, and the same things take place in other animals. External wounds enable us best to observe how inflammation begins and proceeds, as when a member is suddenly cut off or a wound inflicted. For the first few seconds the blood does not flow, owing to the nerve shock, which causes contraction of the vessels. These presently become relaxed, and bleeding follows to an extent dependent on the size and number of the vessels divided. The blood-vessels soon get distended and paralysed. The crowding of the corpuscles is followed by adhesion among them, and exudation, or oozing through the sides or meshes of the vessels, takes place; or they break, and extravasation or diffusion of blood follows, in a more or less clotted condition, into the surrounding tissues. The heat is accounted for by the increased amount of blood, but the actual body temperature is seldom raised more than two or three degrees; the pain is due to pressure on the sentient nerves (the nutrient or controlling nerves are paralysed); the redness in nude portions of the skin is of course due to the abnormal quantity of red corpuscles immediately under it or in it, and the swelling is already accounted for by the exudates. The results or effects of inflammation are said to be resolution, or the cessation of the process; exudation and adhesion, by which wounds are brought together, and, so far as they are concerned, reparative. As affecting internal organs or serous membranes, however, inflammation often produces lasting trouble by the adhesion of surfaces which should be free, an example of which is to be seen in lungs adhering to the sides of the chest after pleurisy or pleuritis. The repair of structures by exudation of lymph, the formation of new blood-vessels, the carrying away or absorption of serous fluid, are among the results of exudative inflammation. Effusion is a very common occurrence in the lower animals, and wounds on the upper portions of the limbs are followed by effusion of fluid, which gravitates to the extremities, often deceiving the amateur as to the seat of injury. Such effusions are not entirely fluid, but contain fibrinous material, which may lead to permanent enlargement if not dispersed. Suppuration, or the formation of pus, is another effect of inflammation, whether in an external part by violence, or in an internal organ by specific infection, as that of strangles or glanders, and may be variously constituted, and described as laudable (promising good results and subsequent repair), sanious or bloody, and imperfect and unfavourable to early recovery, putrid, scrofulous, or tuberculous, &c. Inflammation may result in ulceration or local death, mortification, gangrene (moist or dry), and sloughing or detachment of the diseased parts, and subsequent repair of the remaining healthy tissues. Septicæmia and pyæmia, blood poisoning by absorption of septic matter or pus into the circulation, may be sequelæ of inflammation in any part of the body. Having regard, then, to the various terminations of inflammation, and the degrees of severity of it, our efforts will be directed rather to its control than to the more difficult subject of prevention, so far as the organs are concerned, the causes being generally at work before our attention is directed to the effects. In the matter of external injuries causing inflammation we are in a better position to anticipate it, and even prevent it in many cases, by the prompt employment of antiseptics. See WOUNDS.

The causes of inflammation, besides those already referred to, are various, and not always understood: concussion caused by falls, visible external injuries, nervous shocks, sudden changes of temperature (especially great reduction in a short time), and exposure of the skin to cold winds and draughts of air when the animal is heated by exertion. The custom of clipping horses and then keeping them standing in cold weather while the skin is 'open' as a result of exertion, or of heavy-coated horses, after ploughing and wet with sweat, waiting in exposed situations while they feed from the nose-bag or the teamsters are refreshing, accounts for many cases of inflammation of lungs, pleuræ, bowels, kidneys, and of the mucous membranes, inducing catarrh, bronchitis, pneumonia, fever in the feet, inflammation of the eyes, &c., all of which are considered more particularly under the names of the diseases above specified. Internal inflammation may be the result of poisons (see POISONS AND ANTIDOTES) or of unsuitable food, the stomach, liver, and kidneys being specially liable, as well as the digestive canal. See LIVER, DISEASES OF; COLIC; ENTERITIS; KIDNEY, DISEASES OF, &c.

The *treatment* of inflammation necessarily varies according to the structures involved. In some internal congestions, bleeding from the jugular veins is advised (see BLEEDING). Medicines known as febrifuges are administered, as these are found to lower the tension, reduce the number and increase the force of the heart's contractions, rouse the functional activity of the emunctories, or divert blood from an inter-

nal organ to the skin. Hence such drugs as aconite, digitalis, antimony, camphor, nitre, salycine, antipyrin, and the alkaline bicarbonates and sulphates are administered internally, and warm embrocations externally, or cold evaporating lotions or affusions. Clysters of warm water, or containing anodynes, as opium and belladonna, are directed into the bowels, the urethral canal, or other 'gates and alleys of the body', which are intended either to reach the suffering member, or so nearly approach it as to have a soothing influence (see BLADDER, DISEASES OF, and KIDNEY, DISEASES OF). Vesicating agents in all degrees of strength, from simple ammoniacal liniments, or those with a soap medium (see LINIMENTS), to mustard and vinegar, and cantharides, and biniodide of mercury—all have a place in the armamentarium of the veterinarian fighting inflammation. There are cases, such as indolent ulcers resulting from inflammation or specific disease, cracked heels, languid wounds, and feebly granulating surfaces, when caustic or irritant agents are employed to excite the processes we call inflammation in order to effect repair. Within certain limits, inflammation means increased nutrition. [H. L.]

Influenza, an infectious catarrhal disease of horses which from time to time varies in its manifestations, and during a severe visitation in the United States had the prominent symptom of swollen and inflamed eyes, which gave to it the name of 'pink eye' on the American continent. Although horse-owners are convinced of its infectious nature, it is very erratic in its invasion and sudden departure from a district. It is distinguished from common catarrh (see CATARRH) by extreme depression and weakness from the first. The temperature runs up, the appetite is in abeyance, the pulse small and frequent. There is swelling of the eyelids and intense redness of the conjunctival membranes, and frequently œdematous swellings of the limbs and extreme prostration. Muscular pains, simulating rheumatism, produce a staggering gait when the animal is made to move, and frequent changes of posture fail to relieve the evident pain from which the patient suffers. In some years the digestive system is more particularly involved, and a pasty tongue and sour mouth, yellowish conjunctival membranes, hard and glazed fæces, and high-coloured urine point plainly to a congested condition of the liver. At other times the lungs would appear to be more frequently attacked, and a gangrenous form of pneumonia terminates in death. Although influenza among horses has led to much loss and public inconvenience, it is not strictly speaking a dangerous or frequently fatal malady; but its sequelæ are to be feared when the disease is not early recognized and the patient put under good hygienic conditions. In the great outbreak of 1872 in the United States of America the fatalities were estimated at 7 per cent; but there is reason to suppose that many indifferent horse-masters did not recognize its gravity soon enough, but continued to work horses in the incubative stage, or sent them back to labour too soon. Veterinarians in this country estimate the average mortality at from 1 to 4 per cent. The discharge from the nose would seem in many cases to have a specially irritating effect upon the membranes high up in the nasal passages, and this is held to account for the rather large numbers of cases of nasal gleet which have dated from the convalescent period (see GLEET, NASAL). Thick wind and roaring or whistling are among the serious sequelæ, and abortion in mares. The pulmonary symptoms have in some cases been suddenly relieved and fever in the feet been substituted, an example of metastasis alluded to in connection with congestion of the lungs. See LUNGS, DISEASES OF.

Treatment.—It is above all things important to recognize the symptoms in their inception, and directly a horse is observed to be dull to segregate him, and provide a comfortable well-littered loose box having a pure air supply but free from draughts, and good as to drainage. He should be clothed and hooded, bandaged all the way up the legs, and everything done to promote surface warmth. Carrots and green meat, bran and linseed mashes, hay tea and scalded crushed oats, should be offered him by turns, but nothing left in his manger that he has refused. Stimulating the skin by straw wisps and strapping should be practised two or three times a day while the clothing is removed and replaced, and bandages renewed.

As to medication, there are authorities who hold that it is not of much service; but the practitioners who have had most to do with it strongly believe in the support of alcohol in its various forms during the early depression, and such tonics as quinine in dram doses, with compound infusion of gentian in quantities of half a pint or more, two or three times a day. Whisky in 2 or 3 oz. doses, diluted with four or five times its bulk of water, is much relied on by some to hold up the patient, and in the opinion of these practitioners to shorten the duration of the disease by reducing the period during which the animal seems on the verge of collapse. The writer, who happens to have had a large experience of influenza, thoroughly endorses the view just expressed, and further believes that convalescence is favoured by such tonics, which may be varied by the substitution of phosphoric acid and nux vomica with bitter barks and roots, while reducing the quantity of alcohol in whatever form it may have been given. As previously hinted, the danger comes in when it is desired to put the animal to work, and the veterinary attendant will perhaps do more good by deterring the owner from doing so than by his treatment during the illness. Not until the convalescent has had a week or two of good feeding and shown some gaiety of manner should he be allowed to labour. [H. L.]

Inhabited House Duty.—This tax dates from 1778, and was for a time associated with the window tax. It falls as a general rule upon the occupier. But where a house is let in different tenements, and inhabited by two or more persons or families, the duty is assessed in one sum on the proprietor. The tax is imposed on 'inhabited dwelling-houses' according to

their annual value. In England it has been held that to make a house inhabited someone must sleep on the premises, but in Scotland the ordinary meaning of 'dwelling-house' has been considerably enlarged, and held to include houses which are occupied in different ways, although nobody eats or sleeps in them at all. In ascertaining the value of a house for duty purposes, the value of offices, gardens, and pleasure-grounds to an extent not exceeding one acre, are to be taken into account. Market gardens and nurseries, *bona fide* occupied for the purpose of trade, are not to be taken into account. Premises occupied solely for the purpose of carrying on any profession or trade are not assessable; but if business premises are attached to, or have any communication with, a dwelling-house, they are valued along with the house for assessing the duty. In England every building capable of occupation as a dwelling-house is included in the assessment whether occupied or not; but if not actually occupied during the year of assessment the occupier, on giving notice to the assessor, is entitled to have the tax discharged. In Scotland it is held that in order to attract the duty a house must be occupied; but if a house which was unoccupied at the time of assessment be afterwards occupied, duty will be charged proportionate to the period of occupancy. The year of assessment runs in England from April 6 to April 5, and in Scotland from May 24 to May 23, and the rate varies according to the annual value and the use to which the premises are put. The rates are as follows:—

(1) *Ordinary Dwelling-houses*

Annual value.	Rate.
Not exceeding £40	3*d.* per £.
Exceeding £40 and not exceeding £60	6*d.* ,,
Exceeding £60...	9*d.* ,,

(2) *Dwelling-houses connected with shops or warehouses, hotels, inns, coffee-houses, or farmhouses*

Annual value.	Rate.
Not exceeding £40	2*d.* per £.
Exceeding £40 and not exceeding £60	4*d.* ,,
Exceeding £60	6*d.* ,,

If the annual value of the house is less than £20 there is no liability to the duty.

[D. B.]

Inoculation of Animals.—In preventive—and probably too in curative—medicine, inoculation is likely to play a part more important even than that already taken by it. In this matter the veterinary profession has some advantages denied the medical and older branch, as experimentation with animals having only a financial value permits of conduct inconsistent in human practice and endangering life; indeed this sacred value placed upon human beings is the obstacle which stands in the way at present of deciding absolutely whether or not the tubercle bacillus of man and bovines is identical. Bovines have been inoculated by human tubercle, but men have not been tested by bovine inoculations. Crude methods of inoculation of cattle for the prevention of rinderpest and pleuro-pneumonia found advocates years ago, but the 'stamping-out' system stamped out this practice at the same time, and further progress was arrested until Pasteur cultivated what custom and convenience now calls a 'vaccine' to give protection against anthrax and the sister disease of symptomatic anthrax or quarter ill. Cord preparations, needing no great skill to employ, and affording a large measure of protection, are now in the market, and favourable reports continue to be received from infected districts. A number of expert bacteriologists are working in various parts of the world cultivating the specific bacilli which are known to cause cattle murrains, with a view to discover an attenuated virus which shall give protection by inoculation against the horse sickness of South Africa, red water and black water fly (tsetse), and other tropical diseases. A so-called distemper vaccine cultivated by Dr. Phisalix has been received with much favour on the Continent, but in this country has proved disappointing so far; still, it is in this direction we must look, if ever control is to be gained over that fatal disease of dogs. Mallein and tuberculin testing are commonly spoken of as inoculation, but it should be understood that in neither case is the specific bacillus introduced into the blood of the subject to be tested, but a culture from which the bacilli themselves have been filtered, and only their debris and waste products remain. The effects of such introduction into the blood of a healthy animal with normal temperature is to raise it by a few degrees, and to produce local manifestations which the expert recognizes, and on which he bases his diagnosis. It is significant that in tetanus or lockjaw, which is caused by a specific bacillus, the organisms are not discoverable in the blood, but in the deeper layers of the wound, and when a broken knee of a horse is disinfected to the bottom and no more bacilli are left to poison the blood with their waste products, recovery from tetanus often takes place. Preparations intended to confer immunity against certain specific diseases by inoculation are frequently spoken of as antitoxins.

[H. L.].

Inoculation of Soil.—The fact that the roots of leguminous plants possess nodular swellings, or 'root tubercles' as they are termed, has been known from the earliest days of botanical investigation. The true nature, however, of these tubercles or nodules was not understood until in 1886 Hellriegel showed that the root tubercles of leguminous plants are caused by organisms commonly present in the soil, which infect the younger roots and stimulate growth of the tissues with the formation of nodules. He also demonstrated that tubercle formation and nitrogen assimilation by these plants were interdependent—the more numerous the tubercles the more vigorous were the plants, owing to the increased amount of nitrogen absorbed from the air. As soon as it was recognized that root-tubercle formation and free nitrogen assimilation were dependent on the presence in the soil of specific organisms, the possibility of seeding or 'inoculating' the soil with such organisms was raised.

At first it was the custom to inoculate poor

worn-out land with soil from fields already bearing a good crop of the particular kind of legume to be planted. More recently, however, use has been made of pure cultures of the bacteria found in the root tubercles. The organisms are grown in special culture solutions, and different cultures are prepared for different kinds of leguminous plants.

The numerous and extensive experiments with these cultures during the last few years in Great Britain, Germany, and America, whilst demonstrating the limitations of soil inoculation, have proved what a valuable aid they may be to agriculture when used with judgment

Given suitable conditions, the following advantages may accrue from soil inoculation:—

1. *Increased Yield of Leguminous Crop.*—The amount of increase will naturally vary according to differing conditions, and the greatest increase is to be expected on poor or worn-out soils. Inoculated clover at Rothamsted gave nearly 25 per cent more clover hay than the non-inoculated crop, and at Kilmarnock an inoculated crop of lucerne yielded 12 ton 5 cwt. per acre against 7 tons per acre from the untreated crop.

2. *Increased Fertility of Soil for Succeeding Crops.*—The effect of a leguminous crop on the yield of the succeeding crops is well known to every farmer. This is due to the fact that when the leguminous crop is harvested the nodules remain behind in the ground, and their store of nitrogen is available for the following crop. If by inoculation the quantity of these nodules can be largely increased, the fertility of the soil is proportionately increased.

3. *Increased Feeding Value of Crop owing to Increase of Nitrogenous Contents of Inoculated Plants.* — Recent experiments have demonstrated that the percentage of nitrogen in an inoculated crop is greater than it is in a non-inoculated crop, as much as 50 per cent more in some cases.

4. *Early Maturing of Crop.*—In a number of cases inoculation has hastened the maturing of the crop very materially. Reference to reports shows that ten days, a fortnight, and even three weeks are given as earlier ripening of inoculated crop. With early crops this means earlier marketing and enhanced prices.

It must be remembered that these cultures of nitrogen-fixing bacteria are not to be regarded in the light of nitrogenous fertilizers. The cultures do not contain nitrogen. They simply add to the soil the bacteria which, under favourable conditions, form nodules on leguminous plants and render available the nitrogen from the atmosphere for the growth of these plants. The indiscriminate use of these cultures has led to many failures and disappointments. Soil inoculation is not a panacea for soil ills. The bacteria require suitable soil conditions for the performance of their beneficent work. Soil inoculation, like many other good things, when wisely used will be found both beneficial and profitable, but when used without judgment it is liable to meet with unjust and unfair condemnation. [W. B. B.]

Inostemma inserens. — This minute kind of parasitic hymenopteron is believed to lay its eggs in those of the Wheat Midge (*Diplosis tritici*), by introducing its long ovipositor into the florets early in June, and is thus beneficial in keeping under the multiplication of that injurious fly. *I. inserens* is black, and not a line in length; the antennæ look as if broken, and are clubbed; the head and trunk are dull-black; the body is very polished and pointed; the four wings are stained brown, with a short nervure running less than halfway along the upper ones; base and tips of the fore shanks rusty. The female has a more compact club to the antennæ, she is furnished with a fine curved ovipositor, which is concealed under her body, and the wings are transparent. [J. C.]
[F. V. T.]

Insect Fungus. See Cordyceps.

Insecticides.—These are substances used for the destruction of insects. They may either be employed in a liquid form, so-called washes or sprays, or as powders which are dusted over the destructive creatures, or as vapours. Insecticides may be grouped as follows: (1) Poisons, (2) corrosives, and (3) asphyxiators. The first named are used for all biting-mouthed insects (see art. Entomology); the second for sucking and piercing-mouthed insects; the third group includes vapours of poisonous nature which may be used below ground as well as above, and are used against both biting and sucking mouthed pests. Some of the latter have the fumes given off by mixing certain chemicals (hydrocyanic acid gas), others by heat (sulphur) or burning (tobacco), whilst bisulphide of carbon gives off its vapour naturally. The method of applying insecticides is mainly by means of special machines, such as sprayers, fumigators, and injectors. Spraying machines are fitted with proper nozzles, through which the wash is sent out in as fine a spray as possible, so that every part of the plant is covered. In some cases the insecticide must be sent out in coarser form and with force, notably when woolly insects have to be destroyed. These spraying machines may be carried on the back of men and boys — knapsack sprayers — or drawn by hand or horse power. In large plantations steam apparatus may be used, whilst in gardens fruit and flowers may well be sprayed with hand syringes fitted with proper nozzles. Special apparatus are also made for fumigating under glass with hydrocyanic acid gas, sulphur, pyrethrum, &c., and also 'injectors' for soil treatment. So far as our present knowledge goes, the eggs of insects (except certain Coccids) cannot be destroyed by any liquid applications, but hydrocyanic acid gas will destroy them on dormant wood if used strong enough. Amongst the more important washes used as insecticides we find the following: (i) Caustic or winter washes, (ii) arsenical washes, (iii) oil emulsions, (iv) vegetal washes, and (v) acaricides or mite destroyers.

Caustic or Winter Washes are used for fruit and forest trees, roses, &c., to clean them of the parasitical plant growths, such as mosses, lichens, and algæ. By so doing, the bark of the trees is rendered more healthy, the winter quarters of many noxious insects are destroyed, and certain

BEAN ROOTS
NON-INOCULATED AND INOCULATED

LUCERNE
NON-INOCULATED AND INOCULATED

WINTER TARES
INOCULATED AND NON-INOCULATED

pests, such as scale insects, may be killed. This treatment need only be carried out once every three or four years when trees are once cleaned, unless in a very damp climate. Caustic washes should be used in February or early March, and must never be employed when the buds are opening. The chief winter washes are the following:—

I

Caustic soda (98 per cent) ...	2 to 2½ lb.
Water	10 gal.

II

Iron sulphate	½ lb.
Quicklime	¼ lb.
Caustic soda	2 lb.
Water	10 gal.
Paraffin (solar distillate) ...	5 pt.

The preparation of the former is simple, the soda being merely dissolved in the water. The preparation of the second is as follows: Dissolve the sulphate in 9 gal. of water, slake the lime in a little water, and then add more water so as to make it into a milk of lime; then run the milk of lime into the dissolved sulphate through a fine sieve to strain off grit, then churn the paraffin into the sulphate and lime, and finally add the caustic soda.

III

Lime	3 lb.
Sulphur (flowers of)	3 lb.
Caustic soda	1 lb.
Soft soap	1 lb.
Water	10 gal.

This is what is called the self-boiling lime-sulphur-soda wash. The sulphur is made into a paste and then thinned and poured over the lime; let this boil for a quarter of an hour, then stir, and add the caustic soda; let this boil for some time, and then add the dissolved soap and full quantity of water. Any one of these three will clean the trees and kill a large proportion of scale insects.

IV

Lime	1 to 1½ cwt.
Salt	30 to 40 lb.
Waterglass	5 lb.
Water	100 gal.

This wash also cleans trees, and generally makes them more healthy than those previously mentioned. It is of particular benefit in destroying Psylla or Apple Sucker and Plum Aphis (see special articles), by preventing the hatching out of the embryos. It is prepared by slowly slaking the best fresh lime, and then mixing it in water in which the salt has been dissolved. This should be strained and the dissolved waterglass added. The latter makes the wash hold better on the trees, but is not essential. The thicker it is put on the trees the better. Special nozzles should be used (Seneca nozzles), so as to prevent worry and loss of time through clogging. It may be used right up to the time of the bursting of the buds.

Arsenical Washes are used for biting-mouthed insects, such as caterpillars and beetles. The following are the most important: Arsenate of lead, Paris green, calcium arsenate, London purple, and arsenite of soda. All of them must be sent out in as fine a mist as possible, and must never be used on ripe or ripening fruit, or on any fruit at least four weeks before picking. Care must be taken when using these washes, owing to their poisonous nature.

1. *Arsenate of lead* is prepared as follows:—

Arsenate of soda (pure)	3½ oz.
Acetate of lead	7 oz.
Water	10 gal.

If *dry* arsenate of soda is used, only 2 oz. should be added. The two chemicals are simply dissolved in the water. Arsenate of lead may now be obtained in paste form.

2. *Paris green* is mixed with water at the rate of 1 oz. to 10 gal. It may also be bought in paste form (Blundell's paste) and used in the same proportion. It frequently burns foliage, and has not such killing power as the former.

3. *Calcium arsenate* is made by adding one part of milk of lime to every one part of crystallized sodium arsenate dissolved in 400 to 500 parts of water.

The other two need not be referred to. It is important to use the arsenical washes as soon as the *young* caterpillars are seen.

Contact Washes are mainly used in the form of oil emulsions. These emulsions may be made with soaps or metals. The quantity of oil used depends upon the time of application and the plants to be sprayed. A great deal also depends on the oil used. Some paraffin oils are much more harmful than others, but all do some damage, and these emulsions are not recommended unless it is absolutely necessary to use them. They are beneficial in bad attacks of scale insects, for leaf-hoppers and aphis, but less harmful washes will destroy the latter.

1. *Soap emulsion* for winter use is made as follows:—

Paraffin (White Rose)	1 gal.
Soap	1½ lb.
Water	10 gal.

For summer use, the oil should not be more than 4 pt. The soap is dissolved in boiling water, and when still very hot the oil is churned into it by means of a force pump until the whole is a creamy mass, and then sufficient water is added to bring it up to 10 gal. Solar distillate is best to use for winter work.

2. *Paraffin jelly* is made by boiling 5 gal. of paraffin with 8 lb. of soft soap and adding 1 pt. of cold water, constantly stirring. When cool, this becomes a jelly. Use 10 lb. of the jelly to every 40 gal. of soft water. It is found to be an excellent remedy for red spider.

3. *Metal emulsions* are better for some purposes, and the emulsification is more perfect than where soap is used. The formula is as follows:—

Iron sulphate	10 oz.
Quicklime	5 oz.
Solar distillate oil	24 oz.
Water	10 gal.

Dissolve the sulphate in water and add the lime

water; then churn in the oil, and bring up to 10 gal. by adding soft water.

VEGETAL INSECTICIDES. — These consist of quassia, tobacco, hellebore, and pyrethrum. The former is largely used as an aphicide in combination with soft soap. The others may be used alone or with soft soap.

1. *Quassia Wash* is made as follows: Boil 1 lb. of fresh quassia chips in water for two hours, strain off the extract, and mix it with ½ lb. of soft soap to every 10 gal. of water.

2. *Tobacco Wash* is made by infusing 3 lb. of tobacco powder in water for six hours, then strain off, press, and infuse the tobacco again; add all the extract to 10 gal. of water in which ½ lb. of soft soap has been dissolved. If tobacco leaf is used, ½ lb. is sufficient. This makes a most potent insecticide for Psylla, aphis, and thrips, and will not harm the tenderest plants, even in blossom. It is very penetrative.

3. *Hellebore* is used especially for sawfly larvæ. It must be freshly ground, and mixed with water at the rate of 2 lb. to 10 gal. Sometimes it is employed as a powder dusted over the attacked plants, but it is not so effectual, and the fine powder if drawn up the nostrils may cause profuse bleeding. It must not be used on ripening fruit, or on fruit picked green for four weeks before picking.

4. *Pyrethrum* is sometimes used as a poison for insects on a small scale. Two or three lb. of fresh powder are infused in hot water for three or four hours and then strained off, and the extract mixed with 10 gal. of water. It may be employed with advantage for greenhouse pests, especially as a fumigant. Various preparations are on the market for greenhouse pests, and very fatal they are to aphis, thrips, woodlice, &c. It is quite innocuous to plants. It is also very effective against mosquitoes and other pests in dwellings.

ACARICIDES are related to insecticides, but are used to kill the eight-legged acari or mites. Certain insecticides have the same effect, such as paraffin emulsion and arsenic (the latter used in sheep dips). The chief acaricide is sulphur. Flowers of sulphur and liver of sulphur are the best forms. The latter is potassium sulphide, and is the best to use as a rule. The formula is:—

Potassium sulphide	3 to 5 oz.
Water	10 gal.

This is not only an acaricide, but it is also fungicidal. It may be mixed with paraffin, when it is fatal to certain mealy aphides. See Mealy Plum Aphis (*Hyalopterus pruni*).

Liver of sulphur and paraffin is prepared in the following way:—

Iron sulphate	2 oz.
Quicklime	1 oz.
Paraffin	16 oz.
Potassium sulphide	4 to 6 oz.
Water	10 gal.

Dissolve the sulphate in 6 pt. of water and add the lime, then emulsify with 16 oz. of paraffin, then dissolve the potassium sulphide in 9 gal. of water, and pour the emulsion into it and well mix. This may be used in late winter, and is found effective against combined attacks of red spider and scale.

Fumigation is to destroy insects on living plants and in stored grain, and in buildings, &c. Two well-known fumigants are: (1) hydrocyanic acid gas, and (2) disulphide of carbon.

The former is frequently used for cleaning young dormant fruit trees, and in America and in the Colonies on growing trees in the open. It is especially effectual for scale insects, but all animal life is destroyed by it. Mills, stores, and houses may also be cleared of pests with it, but it is dangerous to work with. If sufficiently strong, it will kill insect eggs also.

The gas is generated by mixing sodium cyanide with sulphuric acid and water in the following proportions:—

Sodium cyanide (125 per cent) ...	1 oz.
Sulphuric acid (sp. gr. 184)	1 oz.
Water	4 oz.

to every 200 cu. ft. of space for dormant fruit trees, to every 1000 cu. ft. for dry green plants. It is prepared as follows: Mix the sulphuric acid and water, and then add the sodium cyanide by dropping it into it. This must be done so that the operator does not inhale any of the generated gas, even for a few seconds. Special apparatus are made for cyaniding (that made by Edwards & Co., nurserymen, of Leeds, is one that is very simple). The temperature of a glasshouse to be fumigated should not be more than 60° F. There should be no sunlight, the plants should be as dry as possible, and they should be subjected to the fumes for forty-five minutes. It is only advised, however, for dormant nursery stock and for vines attacked by mealy bug, owing to its uncertain action on green plants. It must be employed with great care owing to its highly dangerous nature. See FUMIGATION.

Disulphide of carbon is mainly employed for fumigating grain to kill weevils, &c., at the rate of 1 lb. to every 1000 cu. ft. of space. It is also applied as a fumigant for soil pests, especially for root aphides, mole crickets, ants, and larvæ. It has to be injected into the soil to a depth of 6 to 12 in. This is best done with a Vermorel injector. One ounce is sufficient for every square yard. The greater the number of injections the better the results obtained. About 6000 injections are required per acre. It is, however, too costly to use except in gardens and in any special cultivation. It has also a decided beneficial effect on the growth of plants.

Certain *artificial manures* have insecticidal properties. Superphosphates will keep off wireworm if drilled with the seed; kainit has an evil effect on delicate grubs in the soil. But their killing power is very low, and they must not be looked upon as insecticides any more than soot and lime, which at one time were recommended for destroying all manner of insects.

[F. V. T.]

Insectivorous Animals. — The prolific multiplication of insects, which sometimes leads to disastrous results in farm and garden, has its check and counterpart in the large number of

animals which are more or less insectivorous. It is of the utmost importance that this should be recognized by the agriculturist and horticulturist, for a disturbance of the balance of nature by the destruction of the natural enemies of injurious insects is not readily made good by any amount of spraying and dressing. At the same time it must be remembered that many of the insectivorous animals devour useful as well as injurious insects, that several of the insectivorous birds do considerable harm, *e.g.* to buds, in searching for their prey, and that a predominantly insectivorous bird has sometimes vegetarian meals. The farmer has often to pay a tax for his benefits, but past experience goes to show that impatient interference with the natural struggle for existence is usually followed by worse ills than those first rebelled against.

Insectivorous animals are for the most part included in the following classes: (1) Insects, *e.g.* ladybird beetles, which destroy aphides, and ichneumon flies, which destroy many caterpillars; (2) spiders, which destroy large numbers of small insects and should never be killed; (3) freshwater fishes, which eat the aquatic larvæ of many dipterous insects, &c.; (4) amphibians, which are mainly insectivorous as adults; (5) lizards, which are often adept insect catchers; (6) birds, like tits, wrens, wagtails, swallow, martin, swift, wheatear, whinchat, stonechat, flycatchers; and (7) mammals, such as bats and the Insectivora in the strict sense—hedgehogs, shrews, moles, and the like.

The Insectivora proper form a somewhat primitive order, as may be inferred, for instance, from the somewhat simple brain, practically without convolutions, from the fact that the testes remain in the abdomen and are not enclosed in a scrotum, and from the two-horned or double nature of the uterus. The insectivores are small mammals, with soft fur (occasionally with spines), and often with the nose prolonged into a soft snout. The limbs have usually five clawed digits, with the whole palm or sole planted on the ground (plantigrade). In adaptation to the diet of insects, grubs, worms, and the like, the molar teeth bear sharp-pointed cusps, while the small incisors are well suited for picking up small objects. In both these respects, as in most others, the insectivores differ very markedly from the vegetarian rodents, with which they are not nearly related, the resemblance between shrew and mouse, hedgehog and porcupine, and so forth, being quite superficial. The relationships of the insectivores are with the carnivores on the one hand and with the bats on the other. [J. A. T.]

Insects. See ENTOMOLOGY.

Insemination, the transference of the seminal fluid from the male to the female. In mammals, as is stated in the art. IMPREGNATION, rhythmic contractions of the male ducts (vasa deferentia and urethra) and of the penis are brought about by a reflex mechanism, and the seminal fluid is forcibly injected into the vagina. It is important that it should pass up as far as possible, and that it should not be lost by expulsion from the female. There are various adaptations which help this, such as the great length of the penis in many ruminants; the secretion of the vesicular and other glands (usually associated with the male ducts), which serves as a medium for the spermatozoa, and may also coagulate to form a plug in the vagina; the swelling up of the penis during copulation (so much in some cases, notably in the dog, that it is withdrawn with some difficulty); and the property of the spermatozoa which makes them swim against a current. In birds there is no penis, except in a few cases such as ducks and geese, and the seminal fluid is transferred from cloaca to cloaca. Insemination is represented in many animals, *e.g.* most fishes, by the discharge of the spermatozoa upon the already laid eggs. Artificial insemination has been successfully effected in a number of animals, *e.g.* sheep, cows, and mares, and it may be noted that the spermatozoa can be kept alive for a short time in weak solution of common salt. [J. A. T.]

Insemination, Artificial.—The idea of conception without intercourse between the sexes was regarded as one of the fables of the ancients until within comparatively recent times, although it is probable that certain simple manipulations effected the result in a few instances, and that there was greater foundation in fact than even scientists were willing to allow. In America first, and soon after in the chief countries of Europe, artificial insemination was adopted as a means of overcoming barrenness or failure to conceive, which, as has been pointed out in the article dealing with that subject, may be due to some obstruction or impediment in the genital passage, or constricted entrance into the uterine chamber. That constrictions of the *os uteri* were a frequent cause of failure was recognized by breeders, and a practice grew up of introducing the hand into the vagina and employing the fingers to distend the narrow portion (*os uteri*) just prior to service by the stallion or the bull. There is good reason for believing that this method often proved successful, but it could not compare with the introduction direct into the uterus by a pipe carried through the opening, without damage from an acid vagina or other frequent cause of death to spermatozoa (see BARRENNESS). The conveyance of living semen in suitable vehicles at once opens up opportunities of conservation of the seed of valuable stallions, and its transmission to distant places without either animal having to undertake the journey. The seminal fluid is therefore gathered by a syringe from the vagina of the freshly served mare or cow, with certain precautions. The temperature of the syringe must be raised to 100° F., which may be conveniently accomplished by insertion in warm water just before using it. The instrument must be perfectly clean; but if an antiseptic is employed to ensure it, care must be taken that thorough washing follows, or the substance used may prove destructive of the seed. Where natural coitus can be had, the insemination by artificial aid is adopted as an additional insurance, the semen already emitted being then and there used. The mare should be served when the œstrum is fully on, the filled syringe being introduced by one hand, and forced home by compressing the ball

with the other. When more than one mare is to be served, the syringe is again put in a position to draw up seminal fluid remaining on the floor of the vagina, and exposure to light or to cold air studiously avoided, or it may be sterilized. This precaution is still more necessary to observe, if the fertilizing fluid is to be sent away to a distance. It must then be packed in a bottle surrounded by flannel, and with means of keeping up the temperature to about 100° F. The 'Thermos' flask is perhaps the best of all vehicles for the purpose, and we are informed that impregnation has succeeded where the material has been sent many hundreds of miles. [H. L.]

Instinct. See HABITS AND INSTINCTS.

Insurance.—'Insurance is a contract to indemnify against possible or probable loss in consideration of a sum or premium paid or held to be paid.' The contract is embodied in a stamped document known as the *policy*, and by the Stamp Acts, penalties are imposed upon anyone who receives a premium without issuing a duly stamped policy. The consideration for undertaking the risk is the premium. The party undertaking the risk is commonly known as the *insurer*, while the party covered is known as the insured or policy holder. Before there can be any insurance there must be something at risk, but for the purpose of the contract an article may be held to be at risk although it has already perished or been injured, provided this is not known to the parties at the inception of the contract. The article insured must be a lawful subject of trade, thus smuggled goods or contraband of war are not insurable. The subject insured must, moreover, be one in which the insured has an interest, though it is not necessary that the interest be specified in the policy. Any contract of insurance entered into by a person who has no interest, direct or indirect, in the subject insured is invalid by the Gambling Act, 14 Geo. III, c. 48.

Except in the case of insurances on the life of, or against accident to a person, the contract is one of indemnity only, that is to say, it limits but does not measure the liability for loss, and the insured is only entitled to be put in as good a position as he would have been before the loss. The principle of indemnity, however, is not applicable to life or accident insurances. It is further an inherent condition of all contracts of insurance that there must be the utmost good faith on the part of both contracting parties, and any failure in this respect on the part of one of the contracting parties will entitle the other to resile from the contract.

If an insured has any right to reimbursement of his loss from third parties, he is bound, on being indemnified by the insurer, to communicate to him such right. Moreover, if the insured has, from other sources than his insurance, recovered more than his actual loss, he holds such surplus in trust for the insurer who has paid him under the insurance. Consequently the insured is not entitled, without the consent of the insurer, to discharge his right of action against third parties who, by contract or through negligence or default, are liable to indemnify him for the loss sustained. This right, which is known as *subrogation*, is not applicable to the case of life and accident insurances. There, the agreement being to pay a definite sum in the event contemplated, the insurer has no concern with any compensation or damages which the insured or his representatives may be able to claim from other parties.

FIRE INSURANCE.—A contract of fire insurance is one whereby the company—or insurer—undertakes, in exchange for the premium, to indemnify the insured against loss by fire during a stated period to certain specified goods to an extent not exceeding the total sum mentioned in the policy.

1. *Nature of Contract.*—The first principle of insurance law as applicable to loss by fire, is that the contract is one of indemnity, and that both parties have a common interest in the preservation of the thing insured. Hence the insurer is only entitled to be put in as good a position as he was before the fire, and in theory, at least, can never be a gainer by the loss. The second great principle of insurance law is that there must be the utmost good faith on both sides at the inception, and throughout the currency of the contract. This principle is invariably made an express condition of the contract, and all policies embody a clause to the effect that any material misdescription of the property insured, or any misrepresentation or omission of any fact material to be known for estimating the risk, will render the insurance void as to the property affected by such misdescription, misrepresentation, or omission, and that any misstatement in answer to questions put on behalf of the company before or at the time the risk is undertaken will render the policy void. It is to be noted in this connection that even although there is no fraudulent intention, yet if the insurer is deceived the insurance will be void, because the risk run is really different from the risk understood and intended to be run at the time of the agreement.

2. *Insurable Interest.*—By the Gambling Act (14 Geo. III, c. 48) no insurance shall be made by any person on any event whatsoever, wherein the person on whose account the policy is made has no interest. But the interest necessary to validate an insurance may be indirect, thus a trustee, executor, or administrator may insure the trust estate; so may anyone who, though not the owner of it, is liable in restitution of property destroyed by fire. In the same way a tenant who is taken bound to repair and keep in repair the landlord's property has an insurable interest, and even where he is not liable to reinstate premises destroyed by fire, he will have an insurable interest if he continues liable for the rent of the premises, whether rebuilt or not, as is the general rule in England. In Scotland, as a general rule, destruction of the premises will, apart from special agreement, excuse payment of rent, and may terminate the tenancy (see under LEASE). A tenant has an insurable interest in improvements executed by him, for which he is entitled to claim compensation under the Agricultural Holdings Acts. A mortgagee or bondholder has also an insurable interest.

The interest extends only to the actual cost of the property destroyed and not to prospective profits. It does not therefore include the loss of rent, or interest on the value during reinstatement, but rent may, and frequently is, insured by special agreement. Whenever the interest ceases the policy becomes void. In the case of an unconditional sale the property passes whenever the contract is made, even although the time of delivery is postponed, and the risk of fire is therefore on the purchaser. But the purchaser cannot, as a rule, take advantage of the seller's insurance without the consent of the insurer, although some companies make provision for the protection of vendor and purchaser pending completion of the contract. Consequently, on the sale of property on which there is a policy current in name of the seller, it is necessary for the purchaser, as a general rule, to have the policy endorsed at once to cover his interest in the property or to effect a new policy in his own name. On the interest ceasing during the currency of a policy there is no obligation on the company to repay any part of the premium, but it is usual to allow a rebate, which, however, is not necessarily proportionate to the unexpired period of the policy, since the rate for a broken period is always proportionally higher than that for a year.

3. *The Risk.*—The risk insured against is loss by *fire*; that is to say, there must be damage by actual ignition, either of the property itself or of some substance near it not intended to give out heat. But damage to property from smoke or water, arising from the ignition of adjoining property, would entitle the insured to recover. Damage done by explosion of gas—except in gas works—or by bursting of domestic boilers is allowed by most companies. The same is true, apart from special conditions, of gunpowder, but many companies stipulate that only a certain quantity of it shall be kept on the premises, and some refuse to insure it at all. In the case of an installation for electric lighting, it is usually allowed free of extra charge after inspection, but the company should always be notified, as otherwise it will be treated as a special risk. Damage done by lightning, if ignition follows, is covered, but it does not follow that the insurer will be liable for the damage if no fire has ensued. Most companies, however, expressly cover *all* damage done by lightning. In the case of damage to animals by lightning, it is sometimes provided that the company will not be liable unless notice be given them within forty-eight hours, or other short period, of the occurrence. It is usual to provide that the company will not be liable for damage due to the natural heating of hay, corn, seeds, or other property. Deeds and written securities for money, bills or ready money, are invariably excepted from the risk. Special policies may, however, be obtained to cover title deeds, &c., in offices. If after the insurance has been undertaken anything is done whereby the risk is increased, or if the property insured be moved from the place in which it was insured without the consent of the insurer, the policy will become void. Hence if property is removed from one building to another the consent of the insurer by memorandum endorsed on the policy ought at once to be obtained. Most companies, however, allow a proportion of the total sum insured to be set aside to cover household goods temporarily removed from the dwelling-house in which they were insured to any other house, club, or hotel within the United Kingdom at which the insured may be staying, or to a bank or safe deposit, not being part of a furniture depository, on the conditions stated in their prospectus or policy. And similarly an insurance on goods in a coachhouse, stable, or harness room usually extends to cover such goods when temporarily removed to any other coach-house, &c., in the United Kingdom. But in every such case the conditions in the policy will govern the contract and must be carefully studied, or the express consent of the company obtained to the removal. Damage done to goods in transit will not be covered without express agreement. Agricultural implements insured in a particular building are not covered if burnt outside its limits. If, however, they are insured generally, without restriction to a specific building, they are covered wherever burnt. The insurance usually extends to cover the goods of the insured's servants, but not those of his guests unless by express agreement. In the case of policies on agricultural produce it is frequently stipulated that no produce within a hundred yards—or some such distance —of a railway line or of any other hazardous risk will be covered (see under FIRE—RAILWAY FIRES ACT). There is sometimes a condition that no engine worked by steam, gas, oil, or electric power is to be used on the farm. Although as a rule the insurer is only liable for loss sustained as the direct result of fire, the policy will, as a rule, and apart from special condition, cover such consequential loss as damage done to goods in removal from the premises in order to escape destruction, or the loss sustained by theft on the occasion of a fire. Further, it has been said that 'any loss resulting from an apparently necessary and *bona fide* effort to put out a fire, whether it be by spoiling the goods by water, or throwing the articles of furniture out of the window, or even the destroying of a neighbouring house for the purposes of checking the progress of the flames; in a word, every loss that clearly and proximately results, whether directly or indirectly, from the fire, is within the policy' (per Kelly, C. B. in Stanley *v.* Western Insurance Company). This liability on the part of the insurer is the reasonable counterpart to the obligation which rests on the insured to do all in his power to avert the risk and to lessen the resulting damage. 'The person who is protected must neither wilfully cause a loss nor purposely increase or inflame it by wilfully refraining from such obvious, easy, and ordinary exertion as may be always reasonably expected from a person willing to act honestly towards him to whom he looks for indemnity. If the assured wilfully refrains from and neglects to save the insured property, having no reasonable excuse therefor, and having ample means at his disposal so to do, he thereby commits

a fraud on the insurers, whereby he releases them from their contract.'

4. *Premium.* — *Days of Grace.* — The policy usually contains a provision that until payment of the premium the insurance will not be in force. The insurance continues in force till the time fixed by the policy—day and hour being mentioned—or, failing any special time being mentioned, until the latest moment of the last day named. There is, however, usually a provision that the insurance will continue in force until the same hour on the last day of any subsequent period in respect of which the insured shall pay and the insurer shall accept the sum required for the renewal of the insurance. In most cases where the insurance is renewable, there is an allowance of certain days of grace—usually fifteen—during which the renewal premium is payable, and if a fire happens during these days of grace the property is held to be covered even although the premium has not been paid, unless the insurer has previously refused to renew the policy or the insured has no intention to renew, in which case the days of grace are not allowed. But the premium must in any event be paid before the days of grace expire. As a rule, no days of grace are allowed on short-term policies. Most insurance companies send renewal notices to the insured, but they are under no obligation to do so. Where the risk insured against is not run, the premium paid may be recovered. If, therefore, a policy is rendered void through misrepresentation or concealment on the part of the insured, he will, in the absence of fraud, or any stipulation to the contrary in the policy, be entitled to return of the premium paid.

5. *The Loss.*—When a loss occurs, the insured must at once notify the insurer, and it is sometimes stipulated by the policy that this must be done within a given time, when it is essential to a valid claim that this condition be fulfilled. Proof of loss must also be supplied, and while a claim for a greater sum than may actually be awarded would not, without fraud, vitiate the claim, any claim which is fraudulent will result in all benefit under the policy being forfeited. The contract being one of indemnity, the insured is only entitled to recover the actual loss he has sustained in so far as covered by the policy, that is to say, not necessarily what it would cost to replace the property destroyed with new property, but what was its actual market value at the time of the fire. In the case of agricultural produce, this will be, as a rule, the market price of the day, less the price of preparing and bringing the stock to market. But in most leases the tenant is taken bound to consume a portion of the crop—*e.g.* hay and straw—on the land, and not to sell it. In such a case the fodder value of the produce so bound to the farm will be considerably less than the market price, and Woodfall (Landlord and Tenant, 18th ed., p. 848) puts its value at one-half the market price. But such an estimate is not necessarily conclusive, and in each case the whole circumstances must be taken into account in arriving at the fair value. Moreover, the provisions of the Agricultural Holdings Acts relative to freedom of disposal of produce must be borne in mind (see under Agricultural Holdings Acts).

The insurer invariably reserves power either to pay in cash, or, in his option, to replace or reinstate the property. But by an old Act applicable to England, though not to Scotland nor Ireland, the insurer may be required, on the application of any person interested, to lay out the insurance money in rebuilding or reinstating houses or other buildings destroyed by fire. Where the parties cannot agree as to the loss, it is invariably a condition of the contract that the dispute be referred to arbitration.

The insurer, on making payment, is entitled to the advantage of any claim the insurer may have against third parties whose negligence or delict has caused the loss (see above).

6. *Salvage.*—The residue remaining after a fire is termed the salvage, and if the insured was fully covered and the claim is admitted to the full value, the salvage belongs to the insurer, who is entitled to retain, for his own benefit, whatever he can realize for the goods, even although, owing to a rise in the market, he obtains a greater amount than he actually paid to the insured. If, on the other hand, the property is not fully insured on an ordinary policy, and the sum admitted, together with the value of the salvage, does not exceed the loss, the insured is entitled to the salvage.

7. *Contribution and Average.*—In all policies there is a condition that if at the time of loss there shall be a subsisting insurance with another company covering the same property, the company shall not be liable to pay or contribute more than its rateable proportion of such loss. There is further, however, frequently what is known as an average clause, which provides that whenever the sum insured is declared to be subject to average, if the property covered thereby shall, at the breaking out of any fire, be collectively of greater value than the sum insured, then the insured shall be considered as being his own insurer for the difference, and shall bear a rateable share of the loss accordingly. Thus, if property of the value of £1000 be insured for £500, and, through fire, damage is done to the extent of £300, the insured can only recover from the company £150, and must bear the remainder of the loss himself. An average clause is not usual in the case of insurances on private dwelling-houses and their contents, but is very generally inserted in policies covering agricultural produce. As a rule, the clause runs as follows: If the sum insured in agricultural produce, either separately or in one amount with other property, shall, at the breaking out of a fire, be less than three-fourths of the value of all the property insured in that amount, then the insured shall be considered his own insurer for the difference between the sum insured and the full value of the property insured at the time of the fire, and shall bear a rateable share of the loss accordingly.

Insurance of Live Stock.—The numerous risks of loss to which owners of live stock are exposed, through death of, or accident to, the animals owned by them, has led to the develop-

ment of this branch of insurance. The rules of law governing the contract do not differ in any material respect from those which are applicable to insurance generally. The contract is one of indemnity only, and the actual market value must be proved, as already explained.

The risks insured against are very varied. Thus death from accident or disease, or as the effect of an operation, *e.g.* castration, are common risks. Insurances are also frequently issued against barrenness or the risk attendant on parturition; in fact there is almost no reasonable contingency against which an insurance cannot be obtained. As a rule, however, live-stock policies do not cover death from fire or lightning unless expressly included, when an extra premium is usually exacted. Most companies demand notice of illness, accident, or death, within some short period after its occurrence; and such a condition must be strictly complied with, otherwise the claim may be barred.

Some companies will only insure to a partial extent, say two-thirds value, while others undertake the full value. Provision is sometimes also made for the substitution of a new purchase on the sale of the animal originally insured, or for the transfer of the policy to a new owner; but these are special conditions in no way dependent on the general law of insurance, and the terms of each policy must be studied in order to deduce the rights and obligations of the parties to the contract. The same remark applies to the transit and show risks, which are not infrequently included.

In view of the widely differing conditions attached to such policies, proposing insurers should carefully study the prospectus before filling up the proposal form. Moreover, as has been explained, it must be borne in mind that if any of the questions in the proposal form are wrongly answered, such statement, if material, will render the policy void, and this even although the statement is made in good faith. The insured is invariably taken bound expressly to warrant the truth of all the particulars supplied, and consequently any mistake on his part, however innocent, if of such a nature as is calculated to influence the decision of the insurer, will invalidate the contract. [D. B.]

Intensive Gardening.—French gardening, or what is now called 'intensive culture' (as opposed to extensive market gardening), becomes to those even superficially interested in the subject deeply absorbing. The interest has increased since the theory held some time ago, that the climatic conditions in England were wholly unsuited to intensive culture, has been quite exploded. It has now been proved that the climate here is equally well suited,—nay, in many places better adapted to its successful practice than that round Paris, where this system originated.

Although frames or chassis (see art. FRAME) had been in use in the gardens of the nobility and wealthy men in France before 1780, it was not until that year that they were adapted by Monsieur Fournier to market-garden work. He introduced these chassis for the cultivation of the early cabbage lettuce as early as 1780, and of white-topped asparagus in 1792, and cauliflowers in 1811, whereas it was not until 1812 that he applied the same system to the growing of cos lettuces, and in 1826 to the raising of early carrots. To show how enormously this culture has increased we have only to realize that to-day there are at least 3000 ac. round Paris yielding a good living wage to their cultivators. French market gardens of this description were originally called *marais* (the French word for a marsh), as they were on the flat, somewhat marshy ground round Paris. Hence the gardener was called a *maraîcher*, and his system *maraîchère.*

The secret of a successful French garden is without doubt the use of *large* quantities of horse manure year after year. The result of such an accumulation for ten years produces a rich black soil, which is very rich in manurial ingredients and is not less than 1½ ft. in thickness. This fact naturally makes it the most fertile soil that lettuces and early salads can be grown in. Lettuces, as all growers are aware, require rich ground to grow in, and also plenty of water, because they really live on and are largely composed of water—a fact which the French people have for years appreciated. Hotbeds, or as they call them *douces couches*, are composed of fresh stable manure mixed half and half with manure which has quite lost its heat. These hotbeds have about 6 in. of the very rotten manure or soil on the top. The beds are made up in January, and furnish enough heat for the growth of lettuces—*i.e.* 50° F.

We will now suppose that one who is interested in and who understands English gardening desires to make a French garden, and that he has ½ or ¼ ac. of ground at his disposal. For ½ ac. he will require roughly 400 lights (the glass coverings of the frames) and about 1500 cloches or glass bell jars for forcing. This will cost something like £320, which will be capital expenditure, of course. He must see to it that he has a good water supply, as this lessens the cost of initiating a garden; otherwise a small artesian well should be sunk. The manure is the principal yearly expenditure, as the garden must have plenty, and it must be pure horse manure. The cost for this item would be about £100.

Let us take it for granted that the would-be French gardener has arranged for his manure, which he begins to get in in June, building it into a square stack until he has sufficient. In November he will keep the fresh manure by itself, and will mix half and half with what he has already accumulated; about the middle of December or January he will make the necessary number of beds by spreading this equally over the ground to a depth of 18 in., carefully flattening it down, not by stamping on it, but with a flat piece of wood after the style of a turf beater, so that it becomes quite firm on top. On the top of this bed he will put 6 in. of rich garden soil, or better still, if he has it, the rotten manure from the beds the previous year.

In October he will have sown his lettuce seed,

both cos and cabbage, very thinly under cloches, and as soon as they have come up and shown their second rough leaf, he will have to transplant them under other cloches, twenty-five to each cloche. These will then grow and make small hardy plants, and at the end of December or beginning of January they should be sturdy little plants the size of a five-shilling piece. In October he will also have sown his cauliflowers —the early French variety—and will have transplanted them twice in the same manner as the lettuces. These he will have carefully raised on the corner of an old hotbed or under cloches, and after they have been got up, he will prick them out under other cloches; but whereas to the cabbage lettuce he will give as little air as possible, to these cauliflowers he will give as much air as possible. They should be kept under these cloches until they are required in February, or better still, if there is enough room, they should be potted up in small pots and put into frames, having the lights taken off when the weather is sufficiently warm.

We have not yet, however, said anything about cos lettuces, which is one of the most important crops there is. These should be raised under bell-glasses, precisely in the same way as the cabbage lettuces are raised, with this exception, however, that after they have been raised and pricked out in cloches, twenty-five under each, they should have as much air as possible, as cos lettuce delights in having air, whereas the particular cabbage lettuce used for early work will have none of it. The raising of the seed of both cauliflower and lettuce will carry us on to Christmas, when we start making the beds for the ensuing year. It is not desirable to make these beds any earlier than December, unless the produce is for private use, as it is not required by the public generally until later on, salads not being thought of when the weather is extremely cold, as it usually is in December and January.

Now that we have everything ready for business on the 1st January, the beds being made up and the frames placed on top of them, we proceed to plant the frames for the first early crops. We should sow radish very thinly over the frames, and also at the same time sow carrot, the very early forcing variety. This seed *must be sown thinly*, otherwise the carrots will interfere not only with one another's growth, but also with the size of the roots they produce. After having carefully sown these, cover the seeds with about ½ in. of soil. Now proceed to plant the cabbage lettuce which you have under cloches, and you will require to plant thirty-six to each light. When these seeds have been sown and the lettuces planted, there is nothing more to be done except to see the plants do not get dry, which they are not likely to do at that early season, and also to see that there is not too much heat in the beds. If cold weather comes, it will be necessary to see that the beds are carefully lined all round with manure and the frames carefully covered with mats to keep in the heat.

Our would-be French gardener would, of course, have procured mats to cover his frames with. The most serviceable are the mats which the French gardeners use, and which are made entirely of rye straw. These are made exactly the right size to cover three lights. The making of them from rye straw is very easy. You would require three boards on three sides, the exact size of the frame you wish to cover, and you would attach to one end of this frame five rows of tarred cord. These you would carry to one end of the framework and carefully peg into the ground. This being done, you would place a layer of straw on the cords to the depth of 1 in., seeing that the butts of the straw went each side touching the boards, so as to get it an equal thickness. You would have the loose end of the five rows of tarred cord wound round spools. You would take for each a little bundle of straw about 1 in. thick and secure it with a half hitch. After you have hitched up one small piece, you would then proceed with another small bundle in the same way and carefully tighten it, and later on you would very quickly be able to make the desired length of mat.

The beds on which you wish to place your cloches you make precisely the same as if you wished to place a frame on top, but instead of this you put cloches close together. Under each cloche you would put one plant of cos and three plants of cabbage lettuce, and on the whole of the ground taken up by the cloches—which should be placed about 1 in. apart—you would sow a crop of carrots. Then in the space between the cloches you would have a cos lettuce planted, so that after the first lettuces were cut, you would be able to move the cloches over the lettuces growing alongside ready to be forced. The cabbage lettuces would of course be ready and cut the first, and leave room for the cos lettuces to develop. Over the whole of these beds you would sow your carrot seed before planting the lettuces, and this would be the crop that would be ready to come in after the last cos lettuce had been cut. In the very bad weather in January, if there should be any, you would have to cover your cloches with dry litter right up to the top, and over all you would cover with the straw mats already described, to keep the frost out. If the frost should be very severe, the cloches and frames should be covered with two mats, but only while the severe weather lasts. Immediately it improves, of course, take off the coverings. When the lettuces in the frames have been cut, or even before they have been cut, you would plant under each light four of the early French cauliflowers, which should be ready for cutting in May.

We have not yet explained how advisable it is to have strawberries growing in one corner of the garden. Strawberries are a most profitable crop, and are most acceptable when they are ready some weeks before you can get them out-of-doors; if you are growing them for market, they are extremely remunerative. Select the first and strongest runners from plants which you have in your garden, and plant them out in the ordinary way; if you have none, it would be advisable to procure them from a

nurseryman. These will make splendid plants, and will be ready to have the frames placed on them in April, before which time they should not be put on. As soon as the frames are put on, they will immediately begin to grow and show bloom. Straw should be placed round the plants, in the frames, so that the berries do not get rotten. The only care that need be shown to these strawberries is to see that they are well watered and plenty of air given, so that they do not become affected with 'red spider'. They should be ready to pick three or four weeks before outside ones.

The melons which the French people have been growing for so long have now become great favourites with the British people. They are those delicious rock melons, which are quite as good as those we have been in the habit of growing so long in melon pits, and which are, strictly speaking, English varieties. It is necessary to sow the seeds of these melons, and also the cucumbers, in hotbeds in February, so that they may be ready to plant out in beds which have been prepared ready to utilize the frames as soon as they can be taken off the beds in which the lettuces have been grown. As soon as these lettuces have been cut from the frames, the frames are lifted and carried to where the beds have been made ready for the planting of cucumbers and melons. For these a trench should be dug about 9 in. deep, to be filled up with warm manure, a little warmer than that which has been used for the lettuce beds. One cucumber plant or four melon plants should be planted under each light. The melons should be very carefully fertilized, but only one fruit should be left to develop on each plant. This is quite enough, as if one fully developed fruit is cut from each vine it should pay, and if for the private table, it is much better to have one beautiful fruit than several small ones which are of no beauty. The cucumbers should be carefully gone over and stopped, and also the melons. The cucumbers will be ready for cutting from the beginning of June, and the melons the end of June and during July.

There are many auxiliary crops which may be grown in a French garden in the same way. Asparagus may be forced in frames, and also dwarf early peas, potatoes, and dwarf French beans; but we think we have specified the principal things which are the essence of French gardening. Endive may be grown during the summer and carefully bleached.

We must impress upon our readers that the one great thing which will give success is the varieties of lettuce to be grown. It is no good sowing all-the-year-round varieties and thinking that these will bring success; they will not; and if the one particular variety of cabbage lettuce is not used, the garden is foredoomed to failure. This is the same for carrots, of which the very short forcing variety must be used for the early frames.

Even a novice in an elementary way can produce five crops during six or seven months, and if there is nothing more produced during the summer, there will be no great loss in this; but to produce seven crops from one small piece of ground is a little more than is usually attempted. This system of gardening should certainly be attempted by every gardener who has to produce early vegetables for his master. He may think that he knows a great deal about forcing early vegetables, but he is simply forcing them out of their natural time of growth; whereas if he will only adopt the proper varieties for this particular culture, he will really bring them in naturally at the time that they should come in, and delight both himself and his employer.

The size of the frames required is as follows: The box stand should be 13 ft. long by 4 ft. wide, the front 7 in. deep, and the back 9 in. There should be three lights placed in this box, each 4 ft. 7 in. by 4 ft. These special frames can now easily be obtained from any horticultural builder at a cost of about 35*s*., the lights with box complete. The cloches best suited for the purpose are 18 in. in diameter, and should be the French-made ones, as they are peculiarly adapted for this culture owing to the greenish tint of the glass. [C. D. M'K.]

Interest is the price paid by a borrower for the use of money, and is generally charged at a certain rate per cent per annum. Like that of other commodities, the price of loans of money is influenced by supply and demand. When the reserves of cash at the banks become low it is necessary to check further outgoings, and the rate of interest at which the banks will grant loans is raised. As the reserves increase, due to fewer borrowings in consequence of the higher rate of interest, the banks desire to encourage borrowing in order to profitably employ their cash, and the rate of interest is reduced. Interest on money borrowed, say from James Smith, would be entered, when due, in the Journal thus—Interest Dr. £10 to James Smith £10—and the actual payment would be entered in the ordinary course in the Cash Book. The entry for interest due on a sum lent to Smith would be: James Smith Dr. £10 to Interest £10.

The produce or return secured from invested capital is also known as interest. A farmer's income from his business is made up of interest on his capital invested in it, and of profits secured by the employment of his labour and energy. If a portion of the capital were borrowed he would have to pay for the use of it, and if he had a sum invested elsewhere he would not think of treating the income from it as profits of the business. It is evident that before estimating the profits of farming, interest should be charged on capital. The Journal entry is: Interest Dr. £ to capital £. See ACCOUNTS.

[J. O. P.]

Interfering, a peculiarity in some horses caused by hitting the inside of the leg with some part of the foot or shoe of the opposite limb. See BRUSHING.

Intermediate, a term used in horticulture to denote a plant with characters midway between two others, as intermediate stock; or a temperature midway between tropical and temperate; thus we speak of a stove, a greenhouse, and coming between these two in climatic conditions, an intermediate house. [W. W.]

Intestines.—The intestinal tube begins at the pyloric orifice of the stomach, and it terminates on the surface of the body at the anus. It is primarily divided into small and large intestines, and each of these into segments.

The *small intestine* comprises the first portion of the tube, and in a horse of medium size it measures about 72 ft. in length. As is expressed by its name, it is of smaller calibre than the large intestine, and has a smooth contour when distended. The first two feet of the tube occupies a fixed position, and is termed the duodenum; the remainder of the small intestine is loosely suspended, and is divided into jejunum and ileum, the former succeeding the duodenum and measuring about 30 ft., the latter comprising the remainder of the tube—about 40 ft.

The *large intestine* is for the most part of vastly greater calibre than the small, and, unlike the latter, it has, when distended, not a smooth, but a wrinkled surface. In a medium-sized animal it is about 25 ft. in length; it is subdivided into cæcum (or blind pouch), colon, and rectum, the colon being further subdivided into double and single colon.

The functions of the intestines are those of secretion, digestion, and absorption. In the case of the horse, however, it may be said that the stomach plays a very minor part in the performance of these functions, and consequently the full burden of these important physiological processes falls upon the bowels. This accounts for the large size, and the greater vascularity of the intestines in the horse as compared to the ox, whose digestion is largely carried out in the fourth or true stomach; and also for the fact that intestinal disorders, such as colic, inflammation, and twist of the bowels, &c., are much more frequently met with in horses than cattle.

The food when it leaves the stomach is of a consistence somewhat like soft soap, and has a milky-yellow colour. As it passes along the intestines it is mixed with the juices from the pancreas and from the small intestinal glands. These juices act on the various constituents of the food, *i.e.* proteids, carbohydrates, &c., and convert them into more soluble and readily digestible substances.

Absorption of the nutrient products of digestion is carried out by means of small glands called *villi*, which are found chiefly in the large intestine in the horse, and in cattle in both the small and large bowels. These villi are minute finger-like elevations which are distributed along the lining membrane of the intestines, their free end projecting into the canal; they are just visible to the naked eye, but are better seen by means of a pocket lens.

In the substance of the villi are arranged small bloodvessels, and in the centre a special lymph vessel called a lacteal. Certain products of digestion, namely the sugars, are absorbed by the bloodvessels and carried to the liver, where they are stored up (in the liver cells) in the form of glycogen, to be called upon when required; the other products, being absorbed by the lacteals, gain the lymph stream, being eventually emptied into the large veins which discharge their contents into the heart; and in this manner the nutrient products of digestion reach the circulating blood and are distributed all over the body to supply the various tissues and organs. See arts. Bowels and Bowel Diseases, Digestion, &c. [J. R. M'C.]

Intussusception, a telescoping or invagination of the bowel which occurs in spasmodic colic (see art. Colic) from the irritation of parasites, and, it is supposed, during the animal's struggles upon the ground. Veterinarians of the old school were in constant fear of this accident or of twisted gut, and objected to patients being allowed to go down and roll on the ground. The modern view is in favour of allowing the animal to seek relief in a manner involuntarily adopted by persons suffering in a similar way, and it may be supposed that some cases of intussusception are relieved, and the invaginated portion actually released, during the reverse movements of the animal, which does not invariably turn in the same direction. Diagnosis is difficult, as the patient's behaviour, and the great and continuous pain evinced, does not differ materially from that shown in twisted bowel and some other lesions, unless it may be said that the subject of invagination is rather less violent than the horse with twist. The administration of antispasmodics, of oily draughts and anodynes, offers the best means of release. [H. L.]

Inula, a genus of Compositæ, of which about fifty species are known, all natives of the temperate regions of the Old World, six of them being British, including the Fleabane (*I. dysenterica*) and the Elecampane (*I. Helenium*). The latter was formerly cultivated by cottagers for its supposed tonic properties. They are mostly coarse-growing herbs, with flowers after the style of sunflowers. A few of them are cultivated as border plants, the best of these being *I. glandulosa*, with large leaves, and stems about 2 ft. high bearing elegant heads of flowers coloured deep-yellow; and *I. grandiflora*, from the Himalayas, an equally effective plant. They both grow vigorously in any garden soil, and are not particular as to position provided they get plenty of sunshine. [W. W.]

Inventory.—An inventory is a list or schedule of goods, stock, or effects. When an incoming tenant agrees with his predecessor to take over the stock and his entire interests in the holding, the valuer prepares an inventory or complete list stating the details of his valuation, and thus showing how he arrives at his award. It includes, in this case, a valuation of the various classes of live stock, the implements, and the cultivations in preparation for the crops of the following season, as well as the seeds sown, and the unexhausted values of manures and feeding stuffs, and labour in connection therewith. When a proper system of farm accounts is adopted, an inventory is prepared annually at the end of the financial year, when the accounts are closed. This is necessary in order to ascertain the amount of capital invested in the business at the time, or the profit or loss resulting from the year's working on the busi-

ness as a whole, or on the various crops and classes of stock. See Accounts, Farm. [J. O. P.]

Ipomœa, a large genus of the Bindweed family (Convolvulaceæ) with twining stems, and usually large showy flowers coloured purple, white, or yellow. *I. purpurea*, often called *Convolvulus major*, is an annual which grows freely in the open air in summer, and is a charming border plant when allowed to cling to a veranda or pergola. In warm districts *I. Learii*, *I. coccinea*, *I. rubro-cærulea*, and *I. bona nox* may be grown in sunny positions outside, but the seeds require to be sown under glass in February so as to get strong young plants for setting outside in May. The last-named species is one of the most charming of quick-growing free-flowering annual climbers when grown in tropical conditions. The large white flowers are at their best at night. [W. W.]

Ireland, Agriculture of.—Agriculture constitutes by far the largest and most important industry of Ireland. In a country where the range of manufactures is small and restricted—at least on any large scale—to the shipbuilding and linen industries of the north-east, it absorbs the energies of three-fourths of the entire population. A measure of the economic importance which articles of agricultural produce hold in the trade of the country is obtained from the fact that, according to the report on Irish trade for 1907, this group of commodities was estimated to amount in value to more than one-half of the total Irish imports and exports.

According to the figures (unrevised) for 1908, the total area of Ireland amounts to 20,350,725 ac. Excluding the space taken up by woods and plantations, bog and marsh, barren mountain land, waste, &c., the area available for agricultural use reached 17,122,413 ac., and of this in turn 12,502,286 ac. were returned as under permanent pasture, and 4,620,137 ac. under corn crops, green crops, flax, and hay. The foregoing area, however, given under permanent pasture includes approximately 2,500,000 ac. of poor mountain grazing, so that, roughly, 10,000,000 ac. represent the total area of the pasture lands of the country. A gradual shrinkage in the tillage area, which has manifested itself in the extent of corn, green crops, and flax cultivated, and a concomitant extension of the area under hay or permanent pasture, has been a marked feature of the Irish crop areas for the last five decades. The following table indicates both these movements:—

	1867.	1871.	1881.	1891.	1901.	1908.
	acres.	acres.	acres.	acres.	acres.	acres.
Corn crops ...	2,115,700	2,124,034	1,777,175	1,492,763	1,317,574	1,261,662
Green crops ...	1,432,410	1,511,689	1,270,026	1,191,424	1,079,443	1,008,794
Flax	253,257	156,670	147,145	74,665	55,442	46,921
Hay	—	1,829,044	2,001,029	2,059,529	2,178,592	2,302,760

The chief shrinkage, it will be noticeable, has taken place in the area under corn crops and flax, though to a lesser extent in the case of green crops also. In 1908 the area under the several corn crops was divided as follows: Oats, 1,060,483 ac.; barley, 154,395 ac.; wheat, 36,662 ac.; rye, 8039 ac.; beans and pease, 2083 ac. Of the green crops, potatoes (587,230 ac.) were the most extensively grown, the next in order of extent being turnips (278,954 ac.), mangels (72,078 ac.), and cabbage (39,147 ac.). Rape and vetches are very sparingly grown, the area devoted to both falling short of 6000 ac. From the foregoing statement it will thus be seen that oats and barley are the two most extensively grown cereal crops, and that more than three-fourths of the area under green crops is devoted to potatoes and turnips.

The live-stock population of Ireland, according to the returns for 1908, was divided in the following proportions:—Cattle, 4,791,829; sheep, 4,129,623; pigs, 1,217,763; and horses, 604,510. The $4\frac{3}{4}$ millions of cattle are composed, roughly, of $1\frac{1}{2}$ million dairy cows, half-a-million calves, a quarter-million bulls, and $2\frac{1}{4}$ million of one-year-old, two-year-old, and three-year-old animals. Comparatively speaking, cattle constitutes by far the most important branch of Irish live stock, as the following table, which contrasts the numbers of the different classes of live stock kept per 1000 ac. of area in the different countries, shows:—

	Cattle.	Sheep.	Pigs.
Ireland	230	188	65
England	153	464	69
Scotland	61	376	8
Wales	155	775	49

The value, moreover, of the cattle-rearing industry to the country much exceeds that of any other description of live stock, as the following return for 1907 indicates:—

	Total number.	Number exported.	Per cent exported.	Estimated value.
Cattle...	4,676,493	843,010	18	£10,419,430
Sheep...	3,816,609	663,363	17·5	1,267,410
Pigs ...	1,317,068	481,907	36·5	1,636,681
Horses	596,144	33,356	5·5	1,588,441

The geological formation of Ireland, while it supplies a considerable variation of soils in different parts of the country, is responsible for the wide uniformity noticeable in the midland area. This great limestone tract, modified in the chemical and physical character of its overlying soils by the drift deposits of the glacial period, extends from Munster to the confines of Ulster. In Leinster it is intersected by the

granitic area of the Leinster chain; in Munster it gives way through a large area of the Co. Cork to old red sandstone, and is replaced over a large portion of Connaught by the older silurian formation. Still, it is the preponderating origin of Irish soil area, and is equally responsible for the rich grazing plains of Co. Meath, which are noted for their high fattening qualities, as for the valuable dairying districts which extend through Limerick and South Tipperary. Outside of this region the basalt area of Co. Antrim and the schistose soils which prevail in the counties of Donegal and Mayo furnish a lighter type of free-working tillage soils, and in other counties there are variations from the type and characteristics of the soil which extends so widely over the central area. Consequent on the character of the soil it is natural to find that the form of agriculture practised is largely modified. Thus, on the Central Plain, pasture greatly predominates, and live-stock production constitutes the main branch of agriculture. Large numbers of cattle, sheep, and horses are reared annually, but the area devoted to tillage crops is very restricted. Farther south, on the heavy retentive soils of Limerick and Tipperary, milk production is the chief feature of the farming practised. Creameries are numerous in such districts, and the value of each holding is largely calculated on the basis of the number of milch cows which it will carry over a season. On the lighter type of limestone soils met with in South Kildare, Queen's Co., and King's Co., considerable tillage is done, and mixed farming generally prevails. The same system is followed in Wexford, Waterford, and over most of the county of Cork. The inferiority of the soils met with in the Ulster counties precludes them from being given over extensively to pasture; hence in the northern province mixed tillage universally prevails, and every type of crop is grown, with the modification that the flax crop replaces the barley crop of the Leinster and Munster tillage areas.

The rotation practised in Ulster is fairly uniform throughout the province and is of seven years' duration, the order being: oats, flax, green crop, oats (laid down), hay, pasture, pasture. A slight change in the order of crops is found in Co. Antrim, where the following modification exists: oats, green crop, oats, flax (laid down), hay, pasture, pasture. Throughout the midland and southern areas, though no fixed rotation is adopted, the following four-course system is most widespread: roots; wheat, barley, or oats; hay; pasture. The pasture of the fourth year may be grazed for a fifth, sixth, or seventh year according to the requirements of the individual farm, and in this way the four-course shift may be extended into a seven- or eight-course rotation at will.

Chief Crops grown.—Oats is by far the most extensively grown cereal, and is the most general money crop produced in Ireland. In 1907, when 1,075,390 ac. were grown, the average yield returned was 16 cwt., or approximately about 45 bus. per statute acre. While a large proportion of this crop produce is consumed in the country, there is a large quantity exported annually to England and Scotland. Thus in 1907 the export of oats from Ireland to Great Britain reached 1,595,275 cwt., estimated in value at £558,346. In point of quantity Ireland thus stands fourth among the supplying countries, but third in point of value. The comparative figures for 1907 are given in the subjoined table:—

	Quantity.	Value.
Russia	3,256,300 cwt.	£1,054,655
Germany ...	2,294,900 ,,	756,885
Argentina ...	1,645,700 ,,	511,350
Ireland... ...	1,595,275 ,,	558,346
Canada... ...	1,440,700 ,,	476,316

Irish-grown oats shipped to England and Scotland are chiefly required for horse feeding, and the chief centres of export in Ireland are Londonderry, Belfast, Newry, Dundalk, Dublin, Wexford, Waterford, Youghal, and Cork.

The area annually devoted to barley is hardly one-seventh of that devoted to the oat crop. In 1908 the acreage of barley grown amounted to 154,395 ac.; of this area Leinster accounted for 108,179 ac., and Munster for 37,708. The crop is very sparingly grown in either Ulster or Connaught, the area in both these provinces barely exceeding 7000 ac. The chief barley-growing counties are Wexford, Queen's Co., Tipperary, Kilkenny, Cork, King's Co., Kildare, Louth, and to a small extent Carlow, Dublin, Waterford, and Kerry. The average yield per statute acre of the crop is returned for the ten years 1897-1906 as 17·6 cwt., and the average price from year to year approximates to 14*s*. per barrel of 16 stones. All the malting barley grown in Ireland is bought locally for brewing and distilling purposes, the world-famed brewery of Messrs. Guinness & Co. in Dublin being especially large buyers of the home-produced grain. Much inferior or badly saved barley is employed for cattle and pig feeding, and consequently prices for feeding barley are considerably lower than that paid for malting samples. The area under barley, in common with most other tillage crops, has been showing a steady decrease for a number of years past. The difficulty of obtaining efficient labour in some districts, and a general dissatisfaction among growers regarding the existing system of marketing, have been undoubted causes in the above direction; on the other hand, a better knowledge of the manurial requirements necessary for successful cultivation of the crop, and an improvement based on the selection and trial of different varieties, have given greater stability to an industry which is at any time liable to be seriously damaged from a succession of adverse seasons.

The area under wheat in Ireland in 1908 amounted to 36,662 ac., or almost 6000 ac. more than were devoted to the crop in 1904. Within recent years the cultivation of this cereal has increased in popularity with Irish farmers; and though there is little likelihood of the crop ever attaining such proportions in Irish agriculture as it did in 1857, when 577,150 ac. were grown, the recent improvement in prices and the value of wheat for use as domestic food are certain to ensure small areas of it being sown more widely

all over the country. Through the action of the Department of Agriculture, trials of suitable varieties are being conducted in a number of counties, and the effect of this is certain to stimulate the cultivation of a crop which, where the soil is suitable, may profitably replace either oats or barley. The average yield of the ten years 1897–1906 has been returned as 18 cwt., or 7·2 barrels per statute acre, and within that time prices have ranged from 15*s.* to 21*s.* per barrel.

The cultivation of rye is for the most part confined to Connaught, a province which in 1908 was accountable for 3725 out of a total area of 8039 ac. grown. The crop attains its widest popularity in the counties of Mayo and Galway, where it is successfully grown on the moory soils which prevail there. The straw is highly valued for its utility in thatching. Beans and pease are not very generally cultivated. In 1908 the area under beans was returned as 1787 ac., and under pease 296 ac. In the Ulster counties of Antrim, Down, Londonderry, and Donegal, beans find most favour as a field crop; but outside Ulster, Wexford, which in former years grew this crop extensively, is the sole county where any considerable area of beans is now cultivated. The small acreage of pease grown is chiefly restricted to Ulster. The crop finds most favour in certain backward districts of Co. Donegal; the practice there is to sow down the pease along with oats, and to cut both together green, and feed them in this condition as fodder to the live stock.

The area under the potato crop in 1908 (587,230 ac.) represents considerably more than one-half of the total area devoted to green crops. As an article of food which enters largely into the daily diet of rich and poor alike, the crop is regarded in Ireland as of extreme importance, though in contrast with the cereals and some other crops it is of little value as a money crop. According to the official returns, the average yield of potatoes raised per statute acre in Ireland for the ten years 1897–1906 was 4·1 tons. When it is considered that 7 to 8 tons may be expected as a medium average crop on ordinary land with fair manuring and reasonable methods of cultivation, the average yield above quoted may seem difficult to understand. A partial explanation for the low yields shown in the official returns lies in the facts: (*a*) that over large areas in Ireland the potato crop is very roughly and imperfectly cultivated, and on the very poorest class of soils; and (*b*) the necessity for a timely change of seed is not sufficiently recognized. The old Champion variety, introduced over twenty years ago, still retains a large share of its popularity; and though the area devoted to this variety alone, which in 1885 was calculated to amount to nearly 80 per cent of the total acreage under potatoes, has fallen steadily in that period, it is a striking proof of the vitality of this popular variety to find that even yet it represents rather more than one-half of the potatoes grown in the country. Within recent years the manurial and variety tests conducted in each county by the instructors of the Department of Agriculture have been the means of improving both the yield and quality of the crop. Through their efforts also, greater attention is now given all over the country to the necessity of thorough and timely spraying against the effects of the 'potato blight'. When it is remembered that the result of trials conducted in every county has been to show that effective spraying increases the yield per statute acre by over two tons, and materially reduces the proportion of diseased tubers, the general value of this precaution will be appreciated. Further, throughout the congested areas of the western and southern counties, better systems of cultivating the crop are being taught, the value of the boxing system emphasized, the need of replacing worn-out seed by newer and more vigorous varieties demonstrated, and in other directions the more successful cultivation of the crop promoted. As a rule the bulk of the Irish potato crop is consumed on the farms, and, except in some northern counties and within a certain radius of the larger cities and towns, it can be but little regarded as a money crop. From the north of Ireland, however, and more especially from Co. Down, a considerable quantity of potatoes is marketed every year in cross-channel centres. The amount of this trade in 1907 reached 100,309 tons, valued at £394,967, and the comparative extent of this supply in contrast with that from other contributing countries is shown in the following table:—

	Quantity.	Value.
France	149,832 tons.	£852,344
Ireland	100,309 ,,	394,967
Channel Islands...	97,340 ,,	742,578
Holland	63,820 ,,	240,280
Germany	39,988 ,,	148,564

In some portions of counties Dublin, Cork, Waterford, and Sligo, early-potato raising in districts along the seaboard where the soil is suitable has been started, and with such success that it promises to become a permanent feature of Irish agriculture. Though this industry has been in existence for a considerable time in the Rush and Skerries districts of Co. Dublin, it has been due to the efforts of the Department of Agriculture that it has been taken up in a number of other counties. The early varieties grown in Ireland are chiefly Ninety-fold, May Queen, Duke of York, and Epicure. Lifting of the tubers as a rule begins about the 16th or 18th of June, and the aim of the growers is to catch the English and Scotch markets after the supply from Malta and the Channel Islands has been exhausted, and before the first of the Ayrshire supplies has begun to arrive. Obviously the success of the Irish early-potato crop must be largely dependent each year on the nature of the weather during the earlier stages of the growth period; but the fact that cross-channel merchants come each year to visit several of the districts and purchase the growing crops at prices ranging from £30 to £40 per statute acre, indicates the profit possibilities of the crop where the influencing factors are favourable.

Turnips, mangels, and cabbages are the three chief crops grown for cattle feeding, the areas devoted to them in 1908 being 278,954, 72,078,

and 39,147 ac. respectively. Turnips are very widely cultivated in all parts of the country, but the mangel crop, which is not much favoured by Ulster farmers, is most general in Leinster and Munster. Possibly in the two latter provinces, where dairying is more exclusively carried on, the value of the mangel for infeeding to milking cattle until the grass season arrives has been a special reason in commending it to favour. In Ulster, owing to the facts that the rotation practised is more closely observed, and that the climate precludes the wintering out of young cattle which is general in the less exposed districts of the midland and southern provinces, a considerable area of turnips is a necessity on each farm every year; hence throughout this province, as even in such extensive infeeding Leinster and Munster counties as Louth, Dublin, King's Co., South Kildare, Wexford, and parts of Cork, the cultivation of the turnip crop is very widespread. In normal seasons good yields are obtained from both these root crops, and the average return per acre compares favourably with the similar figures for England and Scotland. Cabbages are very generally grown for feeding to milch cows and young stock. Vetches and rape are, however, very sparingly cultivated; the latter crop is most favoured in the eastern portions of Co. Galway, where the practice is to feed it off with sheep.

The flax crop, entirely grown for fibre, is almost wholly restricted to the Ulster counties, and the produce finds a market in the large centres of the linen industry which are situated in and around Belfast. For the past decade the area under flax has, with certain intermediate fluctuations, been diminishing, and in 1908 stood at 46,921 ac., or 12,738 less than in the previous season. The chief flax-growing counties are Down, Tyrone, Antrim, Londonderry, Donegal, and Monaghan. Outside Ulster a small quantity is grown in the counties of Louth and Mayo, and in Co. Cork, where an extensive flax-growing industry flourished years ago, there were still 107 ac. grown in 1908. Flax as a crop is usually grown after oats taken off lea; in the Ulster rotation it never follows on the same soil at a less interval than seven years. If grown within any less period little success is obtained, and as a rule the longer the interval since a preceding crop of flax was grown the more likely are the chances of a profitable crop. The yield of marketable fibre runs from 4 to 6 cwt. per acre, and the price from 50*s.* to 65*s.* per cwt. Occasionally an exceptional yield of 7 to 8 cwt. per statute acre has been obtained, and in some seasons, if the demand for prime flax is good, as high as 70*s.* and even 80*s.* per cwt. has been secured. In quality, Irish flax is intermediate between the coarse Russian fibre (average 35*s.* to 37*s.* per cwt.) and the finer Belgian samples, which range from 60*s.* to 70*s.* and over in value. Large quantities of both these qualities of Continental flax are imported by the leading spinning firms in Ulster each year; indeed the home-grown supply does not amount to one-third of that imported, in either quantity or money value. See FLAX.

The area under hay in Ireland in 1908 amounted to 2,302,760 ac., which was composed of 503,686 ac. under first-crop hay, 345,292 ac. under second and third year's hay, and 1,453,782 ac. of hay from permanent meadow. Nearly all the hay produced in Ireland is consumed within the country; very little is exported in any season; and when the large stock of milch cows and young cattle to be wintered is taken into consideration, the absence of any surplus produce for sale need not cause any surprise. In Leinster and Munster, and throughout the grazing counties generally, the great bulk of the hay is from permanent meadow, while in Ulster a large proportion of it consists of first crop or 'seeds' hay. In the latter province a considerable area of grass is now sown for the express purpose of saving the seed. In 1908 it is estimated that over 75,000 ac. were devoted to this purpose, chiefly in the counties of Down, Armagh, Londonderry, Monaghan, Tyrone, Antrim, Cavan, and Donegal. Perennial Rye Grass, Italian Rye Grass, Mixed Perennial and Italian, and Crested Dog's-tail are the chief grasses grown for seed. The seed of the three former varieties is sown down with oats or other nurse crop in the usual way, but allowed to grow fully three weeks longer than if it were to be cut for hay, so as to allow of the seed being thoroughly ripened. Crested Dog's-tail where grown for seed is sown down by itself at the rate of 20 lb. per statute acre, and if intended for cutting in its first year is forced on by a dressing of artificials; some growers, however, prefer not to cut it for seed until the second year. Saving and threshing is done in the ordinary way, and the average yields obtained are: Italian and Perennial, 5 to 6½ cwt. per statute acre; Crested Dog's-tail, 2 to 4 cwt. Marketing is done at Belfast and the chief provincial towns throughout the growing counties, and the prices realized in 1908 averaged: Italian, 16*s.* per cwt.; Perennial, 15*s.* to 16*s.* per cwt.; Crested Dog's-tail, 80*s.* per cwt. Irish-grown Perennial Rye Grass seed is now counted on the market superior to either Ayrshire or French, and commands the highest quotations.

LIVE STOCK.—*Cattle.*—The two leading features of the cattle-keeping industry in Ireland are: (*a*) milk production, and (*b*) store-cattle raising. With a basis of 1½ million milch cows as a foundation breeding stock, there must be almost a million of surplus cattle available for home consumption and export every year. The money value derived from the sale of the animals exported across channel greatly exceeds the revenue derived from butter production, yet in recent years the tendency is for the butter export to increase in volume and in value, and the cattle export to diminish, so that a levelling up between these two branches of agricultural production may be expected to take place. Owing to the development of the creamery system in Ireland, and the successful efforts made to maintain the uniform quality of Irish creamery butter, and to comply with the requirements of the market in every detail, dairying in Ireland has now attained a prominence which it never before possessed. Taking the figures for 1907 as a comparison between the two sources of income, the

total number of cattle exported was 843,010, valued at £10,419,430, whereas the value of the butter exported in the same year totalled £4,008,220. It will thus be seen that cattle production represents a larger money value; but if from the total numbers of cattle exported, milch cows, fat cattle, and calves be deducted, it is probable that the milk-producing and the store-raising branches are of almost equal magnitude and value. The position which Ireland now holds for butter in the British markets gives much encouragement, and it is almost certain that the output will be found to increase considerably within the next decade. In 1907 the position of the four chief supplying countries on the British market was:—

	Quantity.	Value.
Denmark ...	1,792,114 cwt.	£10,148,184
Ireland... ...	817,994 ,,	4,008,220
Russia	669,748 ,,	3,148,643
Australia ...	599,001 ,,	3,008,298

Of the 843,010 cattle exported in 1907, 492,790 were sent as store cattle and 292,104 as fat cattle. It is probable that the large bulk of the store cattle were sent as two-year-olds, and it is certain that fully three-fourths of the cattle sent out as fat were not infed but finished off on the grass. There is little infeeding of cattle except in certain Ulster counties, and in parts of Louth, Kildare, Wexford, King's Co., and East Cork. Farmers elsewhere who breed cattle sell them off as stores at various ages, and these may be shipped directly, or grazed and passed into other hands before reaching the cross-channel market. Large numbers of Irish store cattle are shipped each year to the infeeding districts of Lincolnshire and Yorkshire as well as to the north of Scotland. The tendency in recent years is to send over Irish stores at an earlier age than formerly, as Scotch feeders especially find it more profitable to get Irish cattle as nine- or ten-months-old calves. Owing to the more extensive use of pure-bred bulls of the Shorthorn, Angus, and Hereford breeds, the quality of Irish store cattle is admitted to have been much improved in recent years, and there is every indication that this branch of farming will continue to be developed by the Irish farmer.

The value of the horse and sheep exports is small compared to that of cattle, but when one remembers that though Ireland sends two out of every three live cattle which are landed at English and Scotch ports, she also sends more than three out of every five horses, and more than six out of every seven sheep.

The following figures for 1907 show the numbers of these classes of stock sent from Ireland and their value, contrasted with the numbers from all other countries:—

	Ireland.		All other Countries.
	Number.	Value.	Number.
Cattle ...	843,010	£10,419,430	472,015
Horses ...	33,356	1,588,441	15,922
Sheep ...	663,363	1,267,410	105,601

There is nothing of note to mention in connection with Irish horse-rearing, except to point out that a strong-boned stamp of the thoroughbred sire is generally used to cross with active bloodlike Irish mares, the result of the cross being animals which make first-class hunters, and have deservedly earned for themselves a reputation all over the world.

The total number of pigs in Ireland in 1908 was returned as 1,217,763, which marks a decrease of almost 100,000 on the preceding year. A shortage in the potato crop, a fall in the price of pork or a rise in the price of feedingstuffs, are all causes which render the pig stock liable to much fluctuation. The short space, however, in which the supply can be increased in response to demand, makes this peculiarity in this branch of live stock possible. Pork production cannot fail to become an increasing feature of Irish agriculture, more especially in light of the reputation which Irish cured bacon and hams hold on the market. Next to the United States and Denmark, Ireland holds third place in the British market, as the following figures for 1907 serve to show:—

	Bacon and Hams.	Value.
United States ...	3,678,305 cwt.	£9,887,623
Denmark ...	1,800,091 ,,	5,368,339
Ireland	979,629 ,,	2,996,951
Canada	923,843 ,,	2,557,153

There is only one other feature of Irish agriculture which need be mentioned, and that is the increasing attention given to the production of eggs and poultry. At the present time the Irish egg trade is only exceeded in bulk by that of Russia, though Ireland takes first place for import value. The four leading countries of supply to the British markets for this class of produce in 1907 were:—

	Eggs (Great Hundreds (120))	Value.
Ireland	6,675,599	£2,920,539
Russia	7,201,275	2,423,978
Denmark	3,665,290	1,711,823
Austria-Hungary ...	2,299,529	872,587

Thanks to the work of the Department of Agriculture and Technical Instruction for Ireland, which was established by Parliament in 1899, the future of Irish agriculture was never more promising. Through the effects of the educational and live-stock schemes, as well as the dissemination of technical information on every aspect of farming, the interest and activity of the Irish farmer has been greatly stimulated, and the advance made in different directions during the past five years may be taken as an earnest of still further progress along the same lines. In what direction the agriculture of Ireland may show the most especial development it is difficult to prophesy, but it is probable that the following branches will be influenced by the general advance:—

1. Live stock, including—(*a*) store-cattle raising; (*b*) fat-cattle production; (*c*) fat sheep and lambs; (*d*) pork (live and dead); (*e*) horse-breeding.
2. Dairying.
3. Poultry and eggs.
4. Certain crops suitable for (1) export, such

as oats, potatoes—early and main crop; and for (2) manufacture, such as flax and tobacco.

[O. W. H. R.]

Iridomyrmex humilis (the Introduced Black Ant).—This is a tropical ant found extending from Mexico to southern Brazil. It has been introduced into Madeira, and unfortunately made its appearance in 1898 in Belfast, where in one locality it became a regular plague. It started in a conservatory and a vinery, and then invaded the house, where the insects increased until they swarmed over everything. The nests were found in the vinery at from 3½ to 4 ft. deep. As it is a serious pest it is well to look out for it in glasshouses, &c., and check it at once by digging up and destroying the nests.

[F. V. T.]

Iris, a genus of about 200 species (ord. Iridaceæ), natives of the northern hemisphere, chiefly in Europe and Asia. It is largely represented in gardens, many of the species ranking with the most popular border plants. The German Iris (*I. germanica*) is so good-natured under cultivation that it may be planted in any out-of-the-way corner and in the poorest soil. It and the Spanish Iris (*I. Xiphion*) and the English Iris (*I. Xiphioides*) have varied so much under cultivation that there are now innumerable named kinds of all three. An iris garden is a special feature at Kew, and in the early summer months it is gay with flowers of the most varied colours. There are two groups: the rhizomatous, represented by the German Iris, and the bulbous, represented by the Spanish Iris. Most of the former are fairly amenable to cultural treatment, but many of the species of the bulbous section are difficult to manage. The most beautiful of them, the Cushion or Oncocylus Irises, are natives of Asia Minor. They have a small bulbous rootstock, short and rather fleshy leaves, and erect scapes bearing enormous flowers of the most extraordinary colours, such as claret-brown, coppery maroon, purple, black and gold, &c. Another charming section of the genus is that represented by *I. persica* and *I. reticulata*. For cultivation in sheltered positions in the rock garden or in a sunny border in front of a building they are unsurpassed, as they flower early in spring, and are both bright-coloured and elegant. Some irises are better grown in or near water, our own Water Flag (*I. Pseudacorus*) being quite worth a place in the water garden; and the conditions suitable for it also suit the Japanese *I. lævigata* (*Kæmpferi*), which is largely grown in the gardens of Japan, and is now fairly common in the bog or water gardens of this country. *I. sibirica* and its varieties also thrive in wet places. The Spanish and English irises are grown in enormous quantities by the Dutch bulb farmers, who sell them very cheaply for planting annually in flower beds to make a display in early summer. *I. florentina*, one of the most beautiful of the flag irises, has a rhizome which is odoriferous and medicinal, and is known as orris root. When dried and finely ground it forms the violet powder of commerce. Most of the species can be readily propagated by division or from offsets; they also seed freely under cultivation. [W. W.]

Iris.—Parasitic Fungi.—

Leaf Rust. — Several forms of rust fungi (*Puccinia*, *Uredo*, &c.) have been observed on cultivated irises, causing brown rust patches on the foliage. *Leaf Blotch* is a common disease, recognized by the leaves showing rounded pale-brown spots with a dark margin, or by the leaves turning brown and rotting; the fungus appears on the patches as olive-brown tufts with large conidia. In *Bulb Scab*, black patches appear on the outside scales and gradually extend inwards; the conidia are dark-brown.

Treatment.—For leaf disease, cupram spray-fluid is recommended (see FUNGICIDES). Bulbs badly attacked by scab are useless, but any slight damage may be checked by soaking the bulbs for two hours in dilute formalin, 1 part in 300 parts water. All varieties are not equally attacked, and for most soils it is possible to find resistant ones. [W. G. S.]

Irish Cattle (Dexters and Kerrys).—Ever since the advent of commerce, the segregation of people in towns, and the improvement of roads and other means of communication, breeds of live stock have diminished in number. At the Lincoln show of the Royal Agricultural Society of England in 1907 there were exhibited only thirteen breeds of English, Welsh, and Scotch cattle, one of them, the Longhorn, coming out as it were to show that it still existed, and two others, the Lincoln and the South Devon, admitted to the national show within recent years only. In the first edition of Youatt's Cattle, published in 1834, over seventy breeds are named and described, most of them now extinct or merged in others better suited to the requirements of the time. Nor, even then, was every breed included.

Had Youatt written a hundred years earlier he would have found breeds not only for every county but almost for every parish: at any rate for every considerable valley or plain fenced in by barriers of sufficient impassability and strength. He would have found no great difference between the cattle of two neighbouring districts, nor, had they been of the same race, between cattle separated by hundreds of miles, or even by so great a barrier as the sea itself. He would have found the cattle of Scotland and the North of England, of Wales, and a large part of Ireland all of the same colour and type. But he would have found the people of each district speaking of their cattle as their own breed, different in some small but distinguishable character from all others; bred always from their own stock, excepting for the occasional intervention of a wanderer from a neighbouring valley which nobody bothered to return, or of a drove which had been stolen or captured from near or distant enemies which nobody ever dreamt of returning.

Had Youatt been a prehistoric Arthur Young he would have described the cattle of these islands as little animals weighing 4 or 5 cwt., with deer-like frames, short black-tipped horns, and black hair broken perhaps on certain parts of the body by white; and he would have described the cattle on the western edges of Europe as of the same race, waiting, as it were, to be

pushed off into the sea by other races swarming westwards. Had he been one of the last of the Romans he would have told how his countrymen introduced to Britain their own white-haired, black-nosed, black-eared cattle to Britain, with horns that were glorious in length, and not only powerful but even graceful in sweep; and he would have told also how from military and other Roman settlements the breed had spread through the country.

Had he been an Englishman of Alfred's or early Norman times he would have told how his forefathers drove the British into the west and stocked the country with red cattle brought over from their own original home in western Germany and Denmark. He would also have told that, excepting in Suffolk and on the coasts of Devon and Somerset, there were nothing but red cattle in the south, and up the east coast perhaps as far as Yorkshire; that the cattle in Wales were black, with an occasional white one; and that in the middle of the country, along the Welsh border and north into Lancashire, there was a mingling of the red Saxons with the Celtic and Romano-Celtic cattle, producing animals whose colours were black, or red, or white, or brindles, and whose horns were very long and of many different shapes.

Had he been a Yorkshireman of Jacobite times he would have told of the great numbers of red-and-white flecked or spotted short-horned cattle brought over from Holland and Flanders in his own and his father's time; and he would have told how these cattle were filling up Durham, Yorkshire, and North Lincolnshire, and penetrating the Longhorn country in the west, and the black-cattle country in the north.

In Ireland there is the selfsame tale to be told: a tale, too, in which similar parts are played by the selfsame races: in which the Celtic black cattle are pushed westwards and westwards by others pouring in from the east. There is this difference, however, that, although the Irish tale begins a thousand years later, it is built upon flimsier foundations, consisting in some part of conjecture and inference resting upon British cattle long deceased upon the one hand and upon Irish cattle still alive upon the other. Irish writings give us little assistance till near the end of the 18th century. The tale must be told, therefore, as many a book is read, by scanning the first and last chapters and filling in the rest.

Just as in Wales or Scotland the old Celtic race is black where it has remained pure, so, in Ireland, it was black also. Our conjecture is confirmed by many authorities, from Arthur Young in 1780 to Youatt in 1834. Let us quote only a few. In Kilkenny 'a few may be seen of the ancient native stock, or what may be supposed so, whose characteristics appear to be upright horns, distant, dry, bent somewhat backwards, and tipped with black; ears rather large; body black, and white face' (Tighe's Agricultural Survey of Kilkenny, published 1802). 'The breed is now a mixed one, of various colours; formerly they were all black' (Townsend's Survey of Cork, 1810). 'This country was formerly remarkable for a very small and beautiful breed of black cattle' (Isaac West's Scenery of Killarney, 1807). 'The native Irish stock were, in my opinion, all black, for though at present there are very few of that colour, they are universally called "black cattle"' (Wakefield's Account of Ireland, 1812). And our conjecture is confirmed again by the facts that where the black race is purest to-day there are most black ones, and its crosses take colours like those from Galloways, Aberdeen-Angus, or Welsh.

It is impossible to say when the eviction of the old Irish race began. Of a large number of skulls found sixty years ago in a crannoge at Dunshaughlin, about fifteen miles north-west of Dublin, and deposited there probably in the 10th century, Sir William Wilde maintained that among the horn-cores he saw four different types: (1) an animal with straight horns; (2) another with longer curved horns, the horn-cores measuring 11 in.; (3) a short horn with 'long narrow face and exceedingly small short-horn cores, curving abruptly upwards, somewhat like the Alderneys of the present day'; and (4) an animal with no horns at all. But to identify these either with predecessors or successors would be difficult indeed, and, after all, perhaps of little help. They show diversity of shape in horn and skull at any rate. Whence had it come? Had it arisen among the native Irish, or had it been introduced from England or Wales? So much of it in a single crannoge points to the disturbing elements having come from a distance, and while the hornless skull points to Scandinavia, the long curved horn-core points to the Lancashire Longhorn. But since we cannot elucidate the matter further now, it can be left.

Just as in Britain, we must look to the movements of the human race for an indication of the movements of cattle. Apart from Norse invasions and frequent comings and goings between Ireland and Scotland, the earliest immigration was that following upon Strongbow's invasion in the 12th century to South Wexford. The immigrants were Normans, English, and Welsh, sailing chiefly from Bristol Channel ports. Their colonization bore little resemblance in the matter of completeness to that of the Anglo-Saxons in England. The settlers did not drive all before them. There are no records to show that they brought over stock; but the homesteads and methods of farming are still to-day more English than Irish in that part of the country, while the cattle approximate more to the West of England type than to any other. The red colour and Devon-like animals are by no means uncommon. Therefore, if we suggested that Lancashire Longhorns may have been imported to Dublin before the 10th century, have we not more justification for suggesting that Devonshire and other West of England cattle were imported to Wexford some centuries later?

At any rate, in whatever way we speculate as to earlier importations, there can be no doubt about the kinds of cattle brought into the country since the great 'plantations' in the 17th century. The north was planted by settlers from

Scotland and the North of England, who, if they brought cattle at all, could bring only black ones similar to those in the country already. The rest of the country was planted with Englishmen, who could bring Lancashire Longhorns from Chester and Lancashire ports, and Devons, or perhaps animals of the Hereford type, from Bristol: those from Chester going to the middle of Ireland, and those from Bristol to the south. There is no more direct evidence that the planters brought cattle from England than that in 1611 the Government drew up regulations restricting the numbers to be imported, and that, according to Arthur Young, the Lancashire Longhorn had wedged itself into complete occupation of the middle and most fertile part of the country long before his visit to Ireland in 1776.

During his visit Young saw a great many newly imported Longhorns brought over to improve those already in the country: most of them still from Lancashire, some from Craven, Canley and other places, and a very considerable number from the great Bakewell himself. The Longhorn not only continued to occupy the great central plain, but to push into the more fertile valleys opening into it upon both sides: leaving to the old Irish and the earlier immigrants from Scotland and the South of England the higher and less fertile country northwards and southwards.

But Young also saw at Doneraile in Cork, and at Archbishop Robinson's (afterwards Lord Rokeby) in Armagh, a few Holderness cattle, forerunners of the Shorthorns that eventually were to do to the Longhorn what the Longhorn had done to the old Irish, excepting that this time the supplanting was to be much more thorough: so thorough, indeed, that before another hundred years the Longhorn was to be almost extinct, and the old Irish to be confined to Kerry and the mountains of Donegal and Connemara. Other breeds were to enter into competition with the Shorthorn: first the Devons in some places in the south, then the Herefords and the Aberdeen-Angus; and the Ayrshires in the north-east; but the great bulk of the cattle in Ireland at the present day are still of the Shorthorn type.

Before coming to close quarters with the remnant of the old Irish race as we find them now in Kerry in their last stronghold, let us look at them as they were seen in some other parts of the country before they became extinct in those parts. The Rev. Mr. Sampson, who wrote the Agricultural Survey of Londonderry, published in 1802, observed 'two varieties of native cows: the one is light in bone, small in size, extremely active, crooked in the ham, with a good eye and sharp nose, and nice thin neck, a crooked horn, frequently turned upward. This strain is generally black, reddish, or brindled, with some white. There is a coarse-boned, ill-shaped breed also; these have swollen bellies, heavy head, a dewlap very pendent, a bull-like aspect.'

In Tyrone, Mr. M'Evoy (1802) says: 'There is here little variation in the breed of black cattle, and especially among the mountainous parts of the country. They are of various colours and shapes, but generally small, as heavy cattle could not subsist upon the scanty fare of our mountains, being principally young heath or *heder*, a common name for heath with the natives, and a coarse kind of carex grass. . . . Though our milch cows are far from being well shaped, they are in general good milkers, to secure which the people take infinite pains. If a person happens on a bad milker, he sells her again as soon as possible, so continues buying and selling till he finds one to answer.' Mr. Anderson of Shelton, in Wicklow, in a letter to Youatt (1834), describes the old Irish cattle there as a low, broad, hardy breed, with thick heads and necks, and a thick hide. Wakefield, in his account of Ireland (1812), describes the old Irish breed thus: 'I have seen some which were pointed out to me as the remains of the ancient breed; they were narrow in the loins and thin in the quarters; they had short legs, large bellies, and white faces; their horns, which turned backwards, were remarkably wide set; they had large dewlaps; but this breed is now almost extinct'. Youatt himself (1834) says of the aboriginal breed: 'They are found in the mountains and rude parts of the country, in almost every district. They are small, light, active, and wild. The head is small, although there are exceptions to this in various parts, and so numerous indeed are these exceptions, that some describe the native Irish cattle as having heavy thick heads and necks; the horns are short compared with the other breed [apparently the Longhorn], all of them fine, some of them rather upright, and frequently, after projecting forward, then turning backward. Although somewhat deficient in the hind-quarters, they are high-boned, and wide over the hips, yet the bone generally is not heavy. The hair is coarse and long; in some places they are black, in others brindled; and in others black or brindled, with white faces. Some are finer in the bone, and finer in the neck, with a good eye, and sharp muzzle, and great activity.'

Thus, before they became extinct excepting in Kerry and its borders, the original black cattle of Ireland were of several colours—black, red, brindle, or one of these colours with white patches—and of two distinct types: one light-limbed and active; the other stouter and thicker, with a large head and short legs.

But in Kerry the two types—one the Kerry, and the other the Dexter—are alive to this day, living in the same district and even in the same fields, breeding together, sometimes each type with its own, but more often the one with the other, yet producing young that always belong to either, never any that seem crosses or half-breds. Most of the Kerry farmers prefer to mate either the Kerry with the Kerry, or the Kerry with the Dexter, for when two Dexters are mated they sometimes throw misshapen calves. The earliest reference to a Kerry as a 'Kerry' is by Arthur Young in 1780. 'The common stock of the mountains (of Kerry) are young cattle bred by the poor people; their breed is the little mountain or Kerry cow, which upon good land gives a great deal of

Photo. G. H. Parsons.

KERRY BULL—"LA MANCHA GORDON"
1ST AND CHAMPION AT THE R.A.S.E. SHOW, 1904

Photo. G. H. Parsons.

KERRY COW—"WALTON BASHFUL"
WINNER OF 1ST PRIZE AT THE BATH AND WEST AND SOUTHERN COUNTIES SHOW, 1908

milk. I have remarked as I travelled through the country much of the Alderney breed in some of them.'

Wakefield in 1812 also mentions the Kerry as being a distinct breed found in the mountainous parts of south-west Cork, and he observes that by frequent crossing with the Longhorn a small breed of nearly the same character was produced.

Then comes Youatt (1834): 'The cow of Kerry is truly a poor man's cow, living everywhere hardy, yielding, for her size, abundance of milk of a good quality, and fattening rapidly when required. The slightest inspection [of a cut in Youatt's book] will convince the reader of the difference between this breed and both the larger and the smaller long-horned Irish one; were it not for the cloddiness about the shoulder, and the shortness and thickness of the lower part of the neck, and the pied colour, we should almost fancy that we saw the middle-horn North Devon cow.'

Last comes Low, who in his Domesticated Animals of the British Isles (1845) says: 'The Kerry cattle of the mountains are generally black, with a white ridge along the spine. . . . They have often also a white streak upon the belly, but they are of various colours, as black, brown, and mixed black and white, or black and brown. Their horns are fine, long, and turned upward at the points. Their skins are soft and unctuous, and of a fine orange tone, which is visible about the eyes, the ears, and the muzzle. Their eyes are lively and bright, and, although their size is diminutive, their shape is good. . . . The peculiar value of the Kerry breed is the adaptability of the females to the purposes of the domestic dairy. In milking properties the Kerry cow, taking size into account, is equal or superior to any in the British Islands.'

After saying 'This fine little breed has been greatly neglected', Low goes on: 'A few honourable exceptions, however, exist to this too general neglect of the mountain dairy breed of Ireland. One attempt had succeeded to such a degree as to form a new breed, which partially exists with the characters communicated to it. It has been termed the Dexter breed. It was formed by the late Mr. Dexter, agent to Maude Lord Hawarden. This gentleman is said to have produced his curious breed by selection from the best of the mountain cattle of the district. He communicated to it a remarkable roundness of form and shortness of legs. The steps, however, by which this improvement was effected, have not been sufficiently recorded, and some doubt may exist whether the original was the pure Kerry, or some other breed proper to the central parts of Ireland now unknown, or whether some foreign blood, as the Dutch, was not mixed with the native race. One character of the Dexter breed is frequently observed in certain cattle of Ireland, namely short legs, and a small space from the knee and hock to the hoofs. . . . When an individual of a Kerry drove appears remarkably round and short-legged, it is common for the country people to call it a Dexter.'

Thus, in Kerry, just as elsewhere, there came to be two breeds of Irish cattle: one light and active, the other short-legged and stout: one, in the implied opinion of Wakefield and Low, the old breed of the country, and the other a new breed originating, according to Wakefield, in crosses between the old breed and the Longhorn, and according to Low, in selections either from the cattle of Kerry or of some other part of the country. Low is somewhat sceptical as to the Dexter being a selected Kerry. But are not the two authors combining to indicate the real origin of the Dexter? We have seen that animals of Dexter type were common in many parts of Ireland—so common in some as to be regarded as the true original breed. And since this type that was so common elsewhere, more especially in the East, was regarded as a new breed in Kerry and West Cork, must we not look for its origin, or at any rate for its first appearance, in the East? And, if so, what was its origin? Mendel's resurrected researches suggest colour as a useful criterion in such a problem. The older colours were black, red, brindle, and these colours with patches of white. For nearly half a century breeders have been tending to eliminate every colour but black, but, although they have nearly eliminated the brindles, there are still many reds, and blacks and reds with white patches. These point to black and red as the original parent colours, with white patches intruding. The original Irish were black; the chief immigrant was the Lancashire Longhorn. The Lancashire Longhorn, as described by Youatt, was 'red roan, with mottled or red legs, and a white streak down the back'. His ancestors were the old British black, the Roman white, and the Anglo-Saxon red cattle. When this mixed and unstable type was put to the Irish black cattle, was it not likely that the union should result in the production of the Anglo-Saxon red again? Are we not justified, therefore, in suggesting that the Dexter is a product of the old Irish black with the Longhorn descendant of the Anglo-Saxon red cattle, or with the Devon, which was imported to the south of Ireland in considerable numbers?

The Kerrys, on the other hand, are the original cattle of the country, breeding true to the original colour like other Celtic races—the white patches and other intrusions of fifty years having been eliminated with ease and success, as was to have been expected in a breed of great age and high purity.

But in spite of, or perhaps because of, their long career of suppression leading almost to extinction, the Kerrys and Dexters have retained their outstanding and most valuable characteristics. Youatt called them the poor man's cow. They are still that and much more. They are any man's cow: the poor man's and the rich: the cow to do well upon poor fare, and better upon rich. They are hardy, good feeders, gentle, great milkers, and excellent fatteners. They have always been in the small farmer's hands—in the hands of men whose farms were never highly productive either in quantity or quality, and whose support has been drawn for centuries from butter and young cattle. It followed as a matter of course that an unprofitable cow was one of the first to join

the grazier's drove. That being so, a cow has been evolved which compares with any of the dairy breeds in the quantity of milk produced to the quantity and quality of food consumed, and is beaten by the Jersey alone for quality. Under good treatment an ordinary Kerry or Dexter weighing 6 or 7 cwt. may be expected to give from 450 to 550 gallons of milk, containing not less than 4 per cent of butter fat, during a season's milking. Cows have been reported to have gone beyond 1000 gallons.

Threatened at one time with extinction, the Kerry breeds have made a wonderful recovery, aided no doubt by the rising demand for dairy products during the last half-century. Kerrys were admitted first to the Royal Dublin Society's shows in 1844. A separate class was provided for Dexters in 1876. In January, 1877, the Farmers' Gazette, an Irish agricultural journal, issued the first 'Register of Pure Kerry Cattle and Dexters', the rights of which were taken over by the Royal Dublin Society when three volumes had been published. In these three volumes, 100 Kerry cows, 46 Kerry bulls, and 10 Dexter cows were entered. Since taking over the Register in 1890, the Royal Dublin Society has seen to the registration of Kerrys and Dexters, and has published annually The Kerry and Dexter Herd Book. A quarter of a century ago the two breeds began to find their way into England, chiefly through the instrumentality of the late Mr. James Robertson of La Mancha, Malahide, County Dublin. At the Royal Agricultural Society's show at Norwich in 1886, Mr. Robertson was awarded second prize for a three-year-old Dexter (Silene) in the class for 'Cows or Heifers of any other breed'. At the Newcastle show next year a class was opened for Kerry (including Dexter-Kerry) bulls, and another for cows or heifers. Two years later at Windsor separate classes were established for Kerrys and Dexters, since which time both breeds have increased in England rapidly.

But there is a possibility that the great success of the two breeds in England may lead to their eclipse in Ireland—to the transfer of their centre of gravity from Ireland to England. Already it has led to the formation of a new society in England—the English Kerry and Dexter Cattle Society (1892)—and to the starting of a second herd book, The English Kerry and Dexter Herd Book (1900).

By the Royal Dublin Society's regulations, animals might enter their herd book through three different channels:—

(*a*) By descent from animals already entered.

(*b*) By gaining 'a Prize or Commendation at any Show held in the United Kingdom, where there is a separate classification for Kerrys and Dexters, provided that the Royal Dublin Society shall nominate the Judges at such Show, and that they comply with the following conditions as to colour:—

'Kerry Bulls shall be pure black, with the exception of a few grey hairs about the organs of generation in animals of exceptional merit.

'Kerry Cows and Heifers must be pure black, with the exception of a small portion of white on the udder in animals of exceptional merit.

'Dexter Bulls and Cows may be either black or red, with a little white.'

(*c*) By inspection. Once a year, meetings were held at certain centres in the Kerry country, where animals were brought for inspection by gentlemen appointed by the Royal Dublin Society, and such cattle as were up to the standard as laid down for the show yard were admitted to the herd book.

Admission by inspection and shows ceased in 1899 for bulls and in 1904 for cows. But as the doors leading into the Royal Dublin Society's Herd Book from the show and inspection channels were closed, doors were opened to the English herd book from the same channels. Thus unregistered cattle may still enter a herd book, but it must be an English one. The English society appointed their own inspectors, and stipulated that they should nominate the judges to shows at which prize animals might qualify for registration. The English society's regulations in the matter of colour are a little different.

The following are taken from the Society's 'standard descriptions': The Kerry cow must be black, but 'a small amount of white on the udder and under line not to disqualify'. 'The bull should be whole black, without a white hair.' Dexters may be 'whole black or whole red (the two colours being of equal merit)'. In a bull, 'a little white on organs of generation not to disqualify an animal which answers all other essentials of this standard description'. A cow may be 'black with white on the udder, or red with white on bag. The extension of the white of the udder slightly along the inside of flank or under side of the belly, or a little white on end of tail, shall not be held to disqualify an animal which answers all other essentials of this standard description.'

Justification for continuing the system of entrance by inspection and shows, and therefore for the action of the English society, might be found in the fact that many unregistered Kerrys and Dexters are still bred and will continue to be bred in Kerry which are equal in merit to animals in either herd book. And so long as the stock of registered Kerrys and Dexters is unequal to the demand, there is a field for the non-pedigree breeders in the ancestral home of the breeds.

There are thus three sets of breeders of Kerrys and Dexters:—

(*a*) The non-registering breeders in the County of Kerry, whose only exports, as of old, are butter and 'black cattle'. Their land consists for the most part of mountain rock and bog, where, with the minimum of shelter, either natural or artificial, their cattle are exposed to the unbroken force of the Atlantic storms. Although the Royal Dublin Society held annual inspections for about fifteen years in Kerry, these breeders showed no inclination to keep pedigree stock. So soon as an animal was passed for registration it was sold and carried away.

(*b*) Pedigree breeders entering their stock in the Royal Dublin Society's Herd Book. The majority of these reside in Ireland, chiefly in Kerry, with a few near Dublin and Belfast,

Photo. G. H. Parsons.

DEXTER BULL—"COWBRIDGE GENERAL"

WINNER OF 1ST PRIZE AND CHAMPIONSHIP, ROYAL LANCS. AND SUSSEX COUNTY SHOWS, 1908

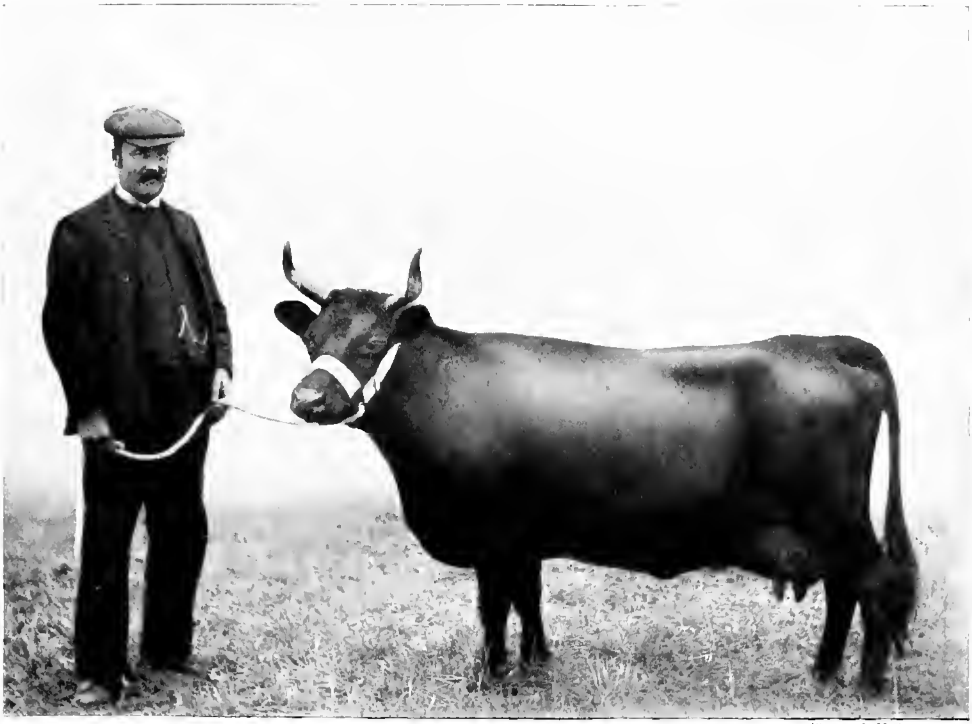


Photo. G. H. Parsons.

DEXTER COW—"COMPTON DOB"

1ST R.A.S.E. SHOW, 1905, AND WINNER OF MANY CHAMPIONSHIPS

and others in isolated places. Until the closing of the Royal Dublin Society's Herd Book the majority of the additions to their stock were drawn from Kerry.

(*c*) Breeders in England and a few in Ireland entering their cattle in the English Kerry and Dexter Herd Book. The majority of these reside in the south of England, and, their herd book being still open, their stocks are recruited from both pedigree and non-pedigree breeders in Ireland.

When crossed with one of the beef breeds, the Dexter produces an animal of outstanding fattening quality. Crosses of the Dexter with the Shorthorn, the Aberdeen-Angus, and the Hereford are features not only of the Dublin but also of the London and Birmingham Christmas shows. A notable attempt has been made at Straffan, in County Kildare, to grade the Dexter with the Shorthorn, and a remarkable type of animal has been produced. After half a dozen crosses it retains the original Dexter characters in a marked degree—the short legs, the stout body, and the Dexter head, with the roan colour of the Shorthorn.

Apart from colour, which has been dealt with already, the two breeds might be contrasted as follows:—

The *Kerry* cow is elegant and deerlike, with light limbs and body, not fleshy, light at the shoulder and deeper in the hind quarters; her skin is soft and unctuous; her head is light and graceful, with bright eyes and ears; her horns are white with black tips, planted widely, not thick at the base, and rising outwards and upwards, often turning inwards towards the points.

The *Dexter* cow has very short limbs and a deeper body; she is therefore less elegant, but no less pleasing; her head is stronger, but very clear cut, shorter below the eyes and broader in the muzzle; her horns are thicker, and usually, after rising upwards, bend backwards towards the points. She is more fleshy than the Kerry, but, even so, looks a better milker. Her udder is larger, and extends farther forward.

The *Kerry* and *Dexter bulls* differ in much the same way as the cows—the Kerry being light in limb and body, and the Dexter short-legged and stout: the one of the dairy and the other of the beef type; the horns are thinner and somewhat upright in the Kerry, and thicker and a little more horizontal in the Dexter; the Dexter head and neck are stronger and heavier. In general outline, the Dexter is very similar to a well-built, low-set North Devon bull.

[J WI.]

Irish Hunter.—The position of honour, in the estimation of sportsmen, to which the Irish hunter has attained, cannot be attributed to any one particular agency, but rather to a combination of circumstances unequalled in any other country. While allowing for the undoubted results of a favourable soil and climate, it is certain that the tastes and character of the Irish people have contributed largely to the success attained. Ireland is, at any rate in many parts, an ideal hunting country, and the people throw themselves into the sport of hunting with that almost passionate enthusiasm which is usual in all their undertakings. Excellent packs of hounds are scattered over the country, in connection with each of which, or at any rate in close proximity, local race meetings are held, at which valuable stakes are offered for the encouragement of local owners and breeders. Facility of disposal, and competition of purchasers, owing to the large number of excellent fairs, have in the past been an additional encouragement to breeders; but it is to be feared, from present observation, that the success of these fairs will in future be diminished, and in consequence the present competition of purchasers, so advantageous to the farmers, will cease to exist. This danger has been pointed out by many leading breeders and dealers, but so far no remedy has been devised to prevent the forestalling of fairs by private sales, which, if extensively continued, will cause many purchasers to cease their attendance at the historic Irish fairs. Soil and climate are undoubtedly important factors in the advancement of the Irish hunter to his present position of eminence, the extensive limestone districts being especially noted for the excellence of the horses raised there. Strength of bone is certainly favoured by the great proportion of lime salts in the soil on which animals are fed, while the comparative mildness of the Irish climate makes it possible to keep young horses out at grass during the winter with only a moderate amount of additional feeding. This results in hardiness of constitution, with increased and earlier development in young Irish horses.

A succession of magnificent sires have left their stamp on the horses of the country from early in the 19th century to the present date, their characteristics being still traceable, as in the case of such sires as Birdcatcher, Arthur, Victor, Harkaway, and others among the older race, and Red Prince II and Ascetic in our own time. Of the original breed of Irish horses upon which the class of modern hunters was founded, there are now practically no survivors. Since early in the 17th century, at least, there have been importations of breeding stock which have left their impress upon the race; but it is agreed among those who have studied the history of horse-breeding in Ireland, that there existed until comparatively recent years a type often spoken of as the 'old Irish draught' horse, which probably resulted from the crossing of imported stallions with native mares, these mares in turn being the descendants of Arab or Barb sires, imported from the 17th century downwards. In the 18th century the introduction of superior sires as well as mares was continued, lists of these importations being still extant, with the names of importers, the Provost of Trinity College, Dublin, being among those who subsidized these attempts to improve the breed of horses. From the crossing of imported stallions with native mares sprang many stallions which sired the great majority of the mares from which subsequent generations of horses sprang; and this method has changed very little even down to our own time, for we find, according to the latest returns, that there are in Ireland in round numbers about 550 thoroughbred sires

to 1100 half-breds and nondescripts, some of the latter being doubtless half-breds, and others of very mixed descent. We are here leaving out of our consideration Shire, Clydesdale, and Hackney horses, the breeding of which is to a great extent confined to certain districts.

We may say, then, that the Irish hunter as we know it, is the descendant of the original native breeds, which had been improved successively by the introduction of Eastern blood, followed by a heavier strain, and lastly by the use of imported thoroughbreds.

Though the value of the thoroughbred sire is not disputed by any authority, yet it is an undoubted fact that some of the best hunters have been the progeny of half-bred stallions; and this fact has been recently to a certain extent recognized by the action of the Department of Agriculture, who are at present devoting considerable sums annually to secure the retention as stallions of the most promising half-bred colts which result from the crossing of the thoroughbred stallions, recognized under their breeding schemes, with approved Irish mares. This has become the more necessary, since of late years Irish sportsmen no longer, as formerly, use entire horses as hunters. Some of these half-bred hunter stallions in former years had great success at the stud, and to a certain extent corrected the evil results of the repeated use of weedy thoroughbreds, which latter course had resulted in the destruction of the 'old Irish draught' horse. It must not be imagined on account of the name that these so-called 'draught' horses were at all similar to the English cart horse, their description being rather that of a general-utility animal, capable of rendering a good account of itself in the hunting field.

System of Breeding.—The modern hunter is most usually bred by the average farmer from one of his working mares, and it cannot be denied that a great many misfits result from present-day methods, among the causes of which may be mentioned: (*a*) the use of unsuitable or unsound sires, and (*b*) the retention and use for breeding of weedy or otherwise unsuitable mares.

In some cases poverty, in others ignorance, cause farmers to use a sire the service of which can be obtained at a small fee, without reference to the fact that he may be of inferior type, unsound, or otherwise unsuitable. Poverty or ignorance also sometimes leads farmers to sell their promising young mares, which are then exported, the unsaleable animal, which may be weedy or unsound, being then retained for work and breeding. This tendency, however, is being strongly combated by the various county committees, who in conjunction with the Department of Agriculture have initiated admirable horse-breeding schemes, under which suitable mares are selected by expert judges and submitted to veterinary examination, on passing which the selected mares are nominated for free service by one or other of the stallions on the register of the Department. These registered stallions have themselves been subjected to critical tests as to suitability and soundness, some of them being purchased with the assistance of the Department.

The breeding mares in Ireland usually continue to do farm work up to the time of foaling, and begin work again within a few weeks while suckling the foal. The latter is weaned in the late autumn, and spends the winter out at grass, generally with access to shelter, some little hand-feeding being allowed. At three years old, and in some cases earlier, the animal is put to a certain amount of light work, after a season of which in most cases he is sold by the smaller farmer to one with greater extent of land, better facilities, or more taste for the further development of the youngster into a complete hunter. At about four years old the real training begins, and a tremendous amount of pains is taken to make the young animal's education complete.

The owner or one of his family will now take advantage of the famous packs of hounds which are to be found studded about the country, to initiate him into the details of his future avocation, the peculiar nature of the fences, banks, and ditches in Ireland bringing out that quality of catlike activity for which Irish hunters are noted. Towards the close of the hunting season, if the young hunter has not happened to catch the eye of a purchaser while performing with hounds, there will come the local race meetings, which usually provide one or two events which give the owner of the newly trained animal an opportunity of distinguishing himself, some of the most famous chasers having made their debut in this manner. In most cases, however, the horse is now prepared either for one of the great fairs to which allusion has already been made, or for the great Dublin show, of which more anon.

Characteristics.—The conformation of the Irish hunter does not show very many marked peculiarities, in fact he may be summed up as possessing those qualities most desirable in a hunter.

His early handling at light agricultural work has made him docile, and in a great measure this accounts for the character of Irish hunters for good manners.

His head is usually well shaped, and shows signs of great intelligence; he has a good rein, with shoulders well set back; a short back, but not too short, the exceptionally strong loins giving it a short appearance; often a tendency to 'goose-rump'; quarters and thighs usually especially well developed; strong hocks, excellent feet, and good bone. The average height is from 15·2 hands to 16·1.

Unsoundness is on the whole exceptional, notwithstanding the mischief done by breeding from unsound sires and mares, the misfits being at an early date relegated to a commercial career. It has been suggested by some, notably by Mr. W. Field, M.P., that all sires should be compulsorily examined as to soundness, and none be allowed to be used for stud purposes which failed to pass this examination.

Some few years ago a great outcry was raised against the introduction of Hackney blood into Ireland, on account of the injury which it was feared would be done to hunter-breeding in Ireland. This agitation resulted in the appointment of a Royal Commission to enquire into the

whole subject of horse-breeding in Ireland, the result of whose report may be seen in many steps since taken, by those in authority, to assist horse-breeding. The horse-breeding schemes are subsidized by the Department of Agriculture, whose officers in 1908 entertained about 300 applications for registration of thoroughbred stallions, of which they rejected 43, while out of 135 half-bred applicants 73 were rejected. In the previous year, 2404 mares received nominations to thoroughbred sires, while 315 mares were sent at Department's expense to half-bred sires, that being the first year in which the half-bred sires were registered.

It will be seen, therefore, that those in authority realize the importance of hunter-breeding as an Irish industry, and are endeavouring to do what is possible to ensure a sound stock in the country. In addition, the Department subsidized local shows throughout the country, gave loans for the purchase of sound thoroughbred and half-bred sires, and took steps to retain a number of promising entire half-bred yearlings, with a view to the use of those selected from among them, as sires in certain districts.

Among the sires, thoroughbred and half-bred, credited with having left their mark on the race of Irish hunters, credit may be given to the following:—

Arthur—said by some to have been the greatest of all hunter sires. It is probable in the case of this horse, as in many others, that many of the horses claiming parentage from him, were as a matter of fact the offspring of his sons, this looseness of nomenclature being common in Ireland.

Victor—almost equally famous.

Reliable—a half-bred son of Victor.

Knave of Hearts—whose memory is still green in the hearts of Tipperary breeders.

Lothario—a western sire.

Harkaway—founder of a famous strain in the north of Ireland.

Mayboy and *Assessor*—two famous Limerick horses.

M'Intosh—whose progeny are to be found as sires at present in Tipperary and Galway.

Coming nearer to our own time we have Bruree, Royal Meath, Roman Bee, Xenophon, Thurles, Sceneshifter, Royal Minister, Ascetic, and Red Prince II, and many others the names of which in many cases can be found in the Department's register.

Lovers of hunting and of the Irish hunter may gather from the foregoing that every effort is being made to maintain the reputation of this, in many senses, unrivalled race of horses. Besides the efforts of the Department of Agriculture, and of race committees throughout the country, there are a very large number of local shows where valuable prizes are offered for competition, jumping contests being particularly popular, and the performances often of a very high order.

No account of the Irish hunter, however, would be complete without a reference to the Royal Dublin Society, which, before the formation of the Department, did a great work in fostering and encouraging high-class horse-breeding, and still holds shows for horses, which are unsurpassed throughout the world. These shows have developed into one of the finest markets for the disposal of high-class horses, more particularly hunters, and attract purchasers from all parts of the Continent, as well as from the great English hunting centres. A good number of hunters come up to the spring show in April each year, this show, however, being intended rather for the encouragement of other branches of agriculture; but in August is held the carnival of the horse, the hunter having chief place, but all other classes being well represented. A first visit to one of these annual re-unions would be a revelation to any lover of a good hunter, the standard of excellence being extremely high. As an evidence of the position which the horse holds in the estimation of the Irish people, these annual meetings have come to be looked upon as the great event of the year, being frequently attended by royalty, and even the humblest peasant is anxious, if possible, to be present at this carnival of the Irish hunter. [F. C. M.]

Irish Land Acts.—General Introduction.—Before dealing with the Irish Land Acts, properly so called, some brief remarks are required (especially for the benefit of those who are not familiar with the law of Ireland) as to the relations of landlord and tenant prior to 1870, the year in which the first of the Land Acts, sometimes described as the Irish Land Code, was passed.

The common law (as distinguished from statute law) of England was extended to Ireland in the reign of Henry II. But the portion of the country under the King's government—'the English Pale'—was, for centuries, comparatively small. Thus in 1518 the Pale is described as extending from Dundalk to Dalkey (eight miles south of Dublin) by a line defined by mention of certain included towns, none of which are situate more than forty miles from the sea coast. The King's jurisdiction was extended gradually by the creation of what was called 'the shire land'. The King had in Ireland the prerogative of creating counties, over which a sheriff was appointed. In these counties the King's writ ran, and with the writ the common law. In the period of the Tudors, also, it was not uncommon for Irish chieftains to surrender their lands to the Crown, and to receive them back, to be held on the conditions of English tenure (*commendation*). In the year 1606 (Case of Gavelkind, Davies's Reports, 134) it was decided that the English common law extended throughout Ireland. The English common law, not only in legal theory, but in actual fact, was introduced into the province of Ulster by the plantation grants made in the reign of James I. From that reign the common law of England and Ireland, especially as regards the law of landlord and tenant, may be regarded as practically identical.

By a statute of the Irish Parliament passed in 1495 (10 Hen. VII, c. 22), commonly called 'Poyning's Law', all statutes of the English Parliament prior to that date extend to Ireland. Statutes of the English Parliament passed after that date, or of the Parliament of Great Britain

subsequent to 1707, do not (generally speaking) apply to Ireland unless re-enacted by the Irish Parliament; statutes passed by the Imperial Parliament since 1801 extend to Ireland unless Ireland is expressly, or by implication, excepted. The pre-Union Acts of the Irish Parliament do not for the purpose of this article require special notice.

While therefore the Irish law of landlord and tenant was in theory the same as that of England, the actual practice and the different economic conditions prevailing in the two countries produced essential differences. Ireland is an agricultural country, and the manufactures few. The tenancies were usually from year to year; leases, except in towns, were the exception. The improvements as a rule were effected by the tenant, and these, according to the law, adhered to the soil, and became the property of the landlord if the tenancy was terminated.

In the west of Ireland the tenancies were often held in intermixed plots or in 'rundale', the tillage lands being held separately, the grazing lands in common. The population had increased in the half-century before the famine years 1846–8, and before emigration had set in. Consequently there was a tendency to subdivide. The result was that the holdings were uneconomic. Hence the necessity, as we shall see, of the recent legislation as to 'congested districts', and the work of the Congested Districts Board; the stringency of the statutes, and of the decisions founded thereon, as regards subletting and subdivision. On the landlord's side also many estates had become heavily incumbered, and such owners were not in a position to promote the improvement of the condition of the tenants. It was believed that the land problem might be solved by the establishment of a Court for the Sale of Incumbered Estates (12 and 13 Vic. c. 77, 1850), and that in the hands of new landlords, successful business men or professional men, the management would proceed on different lines. This Court was reconstituted in 1868 as the Land Judge's Court, which is now, with powers greatly enlarged, a branch of the Chancery Division of the High Court of Justice. The importance of the Court will appear later in the article.

Landlord and Tenant Act, 1860.—This statute (23 and 24 Vic. c. 154), commonly called 'Deasy's Act', places the relation of landlord and tenant upon a new legal basis. 'The relation of landlord and tenant shall be deemed to be founded upon the contract express or implied of the parties, and not upon tenure, and a reversion shall not be necessary to the existence of that relation' (sect. 3). It has been held (Chute *v.* Busteed, 16 I.C.L.R. 222, 1865) that this section of the Act is not retrospective. Deasy's Act consolidates and amends the law of landlord and tenant, and it must be borne in mind that it is a general statute applying to both agricultural and town lettings. A tenancy for a longer period than from year to year must be created by deed or note in writing (sect. 4). Leases not containing a covenant against alienation may be assigned; but where the lease contains a covenant against alienation, an assignment is unlawful (sect. 10) unless the landlord, or his agent duly authorized in writing, consents to the assignment by becoming a party to the instrument of assignment or by endorsing or subscribing a consent thereon. If the provisions of the statute are not complied with, no interest passes, and receipt of rent by the landlord from the assignee does not constitute an estoppel either as against the landlord or the assignor (Donoughmore *v.* Forrest, I.R. 5 C.L. 445; Gillman *v.* Murphy, I.R. 6 C.L. 54; Butler *v.* Smith, 16 I.C.L.R. 213). It has been held, however (*in re* Ulster Permanent Building Society, &c., 13 L.R.I. 67), that where the lease provides that an assignment may take place by a consent endorsed on the lease itself, such consent, endorsed on the lease and not on the instrument of assignment, is valid. If the landlord gives his consent in one of the modes prescribed by section 10, the original lessee is relieved from liability in respect of breaches of covenant by the assignees (sect. 16). The law is altered as regards agricultural and pastoral holdings (see Land Act, 1888, below); whereby, if it can be shown that the landlord, by receipt of rent or otherwise, has consented to the assignment, the assignee may have a fair rent fixed.

Where there is a covenant against subletting, the lessee may not sublet without the consent of his landlord. Consent to subletting, however, differs in two respects from consent to assignment. The landlord's consent to a subletting may be given not only in the two modes set out above under section 10, but also by a written consent, and the agent may give the consent in either of these modes without written authority. It is expressly provided by this section (18) that 'receipt of rent shall not be a waiver'. The words are largely superfluous, inasmuch as, under section 43, waiver, in case of a lease made after the passing of the Act, must be expressed in writing. The effect of section 18 in avoiding sublettings not made in conformity with its provisions is changed by the Land Act, 1896, section 11, which enables sublessees, who can show consent by receipt of rent or otherwise, to have a fair rent fixed against the middleman (see further, below).

No distress can be levied for rent which became due more than one year before making the distress (sect. 51).

A landlord may bring an ejectment for non-payment of rent where a year's rent is due over and above all just allowances. After judgment or decree, the tenant has six months in which he may redeem. The procedure in such cases is regulated by sections 52–71. An action of ejectment for non-payment of rent does not lie under section 52 in respect of tenancies less than tenancies from year to year (O'Sullivan *v.* Ambrose, 32 L.R.I. 102). A further change in ejectment for non-payment of rent, as to agricultural or pastoral holdings, is made by the Land Act, 1887, section 7 (sometimes called 'the eviction-made-easy clause'). The landlord, six weeks after the recovery of the judgment or decree, by taking the prescribed steps, may turn the tenant into a caretaker. Six months

later all right of redemption is gone, and the landlord may recover possession by a magistrate's order. The Land Act, 1896, section 16, enacts that in the case of such holdings not more than two years' arrears of rent can be recovered in case of ejectments for non-payment of rent, either in the ejectment proceedings or by distrees; but the balance of the rent then due is recoverable by the landlord as a debt.

Deasy's Act also defines the law as to covenants running with land or the reversion, waste, emblements, implied covenants on the part of the landlord and of the tenant, the procedure in ejectment for overholding, and other matters. Inasmuch as Deasy's Act is not one of 'the Irish Land Acts' within the meaning of the article, it is only necessary to indicate the general scope of its provisions.

The Irish Land Code deals with land law and land purchase. Some of the statutes, however, are wholly or mainly Land Purchase Acts. The Land Acts 1896 and 1903 define the statutes or portions of statutes which are 'Land Law Acts' and those which are 'Land Purchase Acts' (Land Act, 1896, sect. 48, and Land Law Act, 1903, sect. 98). The division of the article in general follows this line of demarcation, but, for the sake of convenience, with some small and unimportant deviations.

LAND LAW

The Land Act, 1870.—The first of the Land Acts, properly so called, conferred important rights upon the tenant. The usages known as the Ulster Custom, and analogous usages existing in other parts of Ireland, were legalized; the tenant was given a right to compensation for disturbance, and for improvements.

(*a*) *The Ulster Custom.*—The usages known as the Ulster Custom vary very much in different counties, and on different estates in the same county. The Act recognizes this fact by the employment of the plural—'the usages'—and therefore does not attempt any general definition of the custom. We are not, however, without judicial definition. 'Speaking for myself, it seems to me that the important essentials of the custom are the right to sell, to have the incoming tenant, if there be no reasonable objection to him, recognized by the landlord, and to have a sum of money paid for the interest and the tenancy transferred. I think, if any of these ingredients are absent, the essentials of the Ulster tenant-right custom are wanting' (*per* Porter, M.R., M'Elroy *v.* Brooke, 16 L.R.I. 75). It must be proved that the custom attaches to the holding, but evidence is admissible, for this purpose, that the custom exists on other holdings on the same estate, or even, especially in the case of a small estate, that it applies generally in the whole district. It is not, however, sufficient proof of the custom to show that it prevails upon some neighbouring estates even if adjoining. A tenant under the Ulster Custom may elect to claim under the sections as to compensation for disturbance and improvements, if this course should be more beneficial to him than a claim under the custom.

(*b*) *Compensation for Disturbance.*—In the case of tenancies from year to year created after August 1, 1870, or of tenancies existing on that date where the annual value does not exceed £100, or of tenancies under leases made after August 1, 1870, for a term of less than thirty-one years or for a life or lives, the tenant, if 'disturbed' by his landlord, may claim compensation according to a fixed scale (sect. 3, as amended by Land Act, 1881, sect. 6). No definition of 'disturbance' is given in the Act, but it is provided (sect. 9) that ejectment for non-payment of rent, or for breach of a covenant against assignment, subletting, or in case of bankruptcy, or for obstruction of the landlord in the exercise of his rights as to mining, &c. (sect. 14), shall not be deemed a disturbance of the tenant, and on the hearing of such claims all equities and questions of set-off must be taken into account (sect. 18). 'Disturbance', says FitzGibbon, L.J., in O'Donovan *v.* Kenmare, 1896 (2 I.R., at p. 526), 'must mean a disturbance of possession in fact.' Disturbance is not defined in the Act. See also Fitzsimons *v.* Clive, 12 I.L.T.R. 12.

(*c*) *Compensation for Improvements.*—By section 70, 'improvements' mean (1) any work which, being executed, adds to the letting value of the holding and is suitable to such holding; also (2) tillages, manures, or other like farming works, the value of which is unexhausted at the time of the tenant quitting his holding. A tenant not within, or, if so, not claiming under, the Ulster Custom may, in addition to compensation for disturbance under section 3, claim also the value of improvements (sect. 4) made by himself or his predecessors in title. The tenant, however, is not entitled to any compensation in respect of the following improvements: (1) If made before August 1, 1870, and twenty years old at the date of the making of the claim, except permanent buildings (now by the Land Act, 1896, sect. 48, extended to include permanent structures and sea and river embankments) and reclamation of waste land.

(2) If prohibited in writing by the landlord as being calculated to diminish the letting value of the holding, and made within two years after the date of the passing of the Act, or during the unexpired residue of a lease granted before the passing of the Act.

(3) When made in pursuance of a contract for valuable consideration.

(4) In contravention of a contract not to make them.

(5) In the cases of leases made before the passing of the Act, where the right to compensation is excluded by the lease.

(6) In the case of leases for not less than thirty-one years, whether made before or after the passing of the Act, or in the case of leases made before the passing of the Act for a life or lives, whether with or without a concurrent term of years, and which lease has actually existed for thirty-one years, unless there is a provision for compensation in the lease, except permanent buildings, reclamation of waste land, and unexhausted tillages and manures.

(7) Where the tenant is voluntarily quitting his holding and the landlord has given him per-

mission to dispose of his interests in the improvements to the incoming tenant.

(8) If the landlord has agreed to make the improvement and he has not been guilty of unreasonable delay.

The improvements are presumed to have been made by the tenant except in the following cases:—

(1) Where made before the landlord bought the estate.

(2) If the tenant held under a lease.

(3) Where the rateable value of the holding is over £100 per annum.

(4) Where the improvements were made twenty years or upwards before the passing of the Act.

(5) Where it appears that the landlord was in the habit of making the improvements.

(6) If the Court, from the whole circumstances of the case, is reasonably satisfied that the improvements were not made by the tenant or his predecessors in title.

Holdings under the Ulster tenant-right custom are in a much better position, inasmuch as there is a general presumption that the improvements have been made by the tenant. The term 'predecessors in title' received a very strict construction under the Act of 1870. In the case of Holt *v.* Harberton (6 I.L.T.R. 1) it was held that, in order to entitle the tenant to claim, the improvement must have been made by a predecessor in the same legal title. This has been amended by the Act of 1881 (sect. 7), which gives the right to claim for improvements notwithstanding breaks in the title, provided that there is substantially a continuance of the interest in the holding, although there may not be a succession to the same legal title. The exceptions and presumptions as to improvements in the Act of 1870 were of great importance in the fixing of fair rents under the Land Act, 1881, as a result of the case of Adams *v.* Dunseath (see below).

The Land Act, 1870, applies only to agricultural or pastoral holdings, or holdings which are partly agricultural and partly pastoral (sect. 71). Demesne lands, town parks, pasture farms under £50 annual rateable value, lettings to labourers or hired servants, lettings in conacre, or for the purposes of agistment, or temporary depasturage, or for temporary convenience, are exempted from the operation of the Act, except that in the case of demesne lands, town parks, and pasture farms the tenant may claim for improvements. The nature of these holdings and others exempted from the Land Law Acts will be dealt with under the Land Act, 1881.

The Land Act, 1881, and the Amending Land Law Acts.—The Land Act, 1881, is the principal Land Law Act, and the subsequent Land Law Acts may be treated as amendments of it. The Act of 1887 made radical changes, especially as regards the position of leaseholders. Two minor statutes were passed in 1887 and 1888 (affecting the same class of holders), and important changes were made by the Land Act, 1896.

In order to understand the scope of the Land Act, 1881, it must be borne in mind that its primary object was to benefit 'the present tenants'. 'Present tenancy' is defined (sect. 57) as a tenancy subsisting at the date of the passing of the Act (August 22, 1881), or created before January 1, 1883, in a holding in which a tenancy was subsisting at the time of the passing of the Act. Every tenancy to which the Act applies shall be deemed to be a present tenancy until the contrary is proved. In the case of 'future tenancies' it was considered that the tenants should be able to make bargains for themselves. Neither were leaseholders originally contemplated as coming within the scope of the proposed legislation. 'We must not', it was said in the debate on the second reading, 'lightly interfere with the freedom of contract.' Both classes, however, had certain rights conferred upon them by the Act, and later legislation has been very much in favour of leaseholders.

The Land Act, 1881, conferred upon the present tenants: (1) the right of free sale; (2) fair rent; and (3) fixity of tenure: as it is popularly said, 'the three F.'s'.

(1) *Right of Free Sale.*—A tenant desirous of selling the interest in his holding must first give notice of his intention to his landlord, who may, if he wishes, exercise the right of pre-emption. If the landlord and tenant cannot agree as to the price, it will be settled by the Court. Should the landlord not claim the right of pre-emption, the tenant may sell to any purchaser; but he must give a notice to the landlord stating the name of the purchaser, the amount of the purchase money, and certain other particulars. The landlord may object to the purchaser on reasonable grounds, which will be determined by the Court if necessary. The landlord has a first claim, as against the purchase money, for arrears of rent and breaches of the contract and conditions of the tenancy. The landlord must give notice of his claim both to the outgoing tenant and the purchaser. If the outgoing tenant does not dispute such claims, the purchaser must pay them to the landlord; but if the outgoing tenant serves a notice upon the purchaser, the latter must pay to the landlord only the amount of the claims admitted by the outgoing tenant, and, out of the purchase money, pay into Court the residue of the amount claimed by the landlord. The Court will determine all questions relating to the sum paid into Court, on the application of any or all of the parties. A tenant holding under the Ulster tenant-right custom may sell either under the Act or under the custom, whichever he considers the more beneficial to him; but he is not entitled to sell partly under the one and partly under the other (sect. 1).

(2) *Fair Rent.*—The tenant may apply to the Court to have a fair rent, *i.e.* a judicial rent, fixed; the rent so fixed normally continues for fifteen years. On the hearing of such applications the provisions of the Land Act, 1870, were of great importance under the fair-rent-fixing provisions of the Land Act, 1881, in consequence of the decision in Adams *v.* Dunseath (10 L.R.I. 109). Section 8 (9) of the Land Act, 1881, provides that no rent shall be put upon a tenant's 'improvements', but no definition of 'improvements' is given in the

statute. It was held that inasmuch as the Acts of 1870 and 1881 are *in pari materia*, the provisions of the Act of 1870 must be read into the Act of 1881, and that rent may be put on such improvements as the tenant could not claim compensation for if quitting his holding, and that the burden of proof was the same as under the Act of 1870. This has been largely modified by the Land Act, 1896, section 1. The improvements upon which rent can now be put are improvements (other than permanent buildings and reclamation of waste land) made before August 1, 1850. The same section contains other exemptions from rent upon tenants' improvements, and requires the Court to set out the particulars of the improvements and the grounds of the decision in the form of a schedule. The tenant is not entitled to have a fair rent fixed unless he is substantially in occupation of the holding. A tenant who had sublet even a very small portion of the holding without the consent of his landlord could not get a fair rent fixed under the Act of 1881. The Land Act, 1887, enacted that a tenant should be deemed to be in *bona fide* occupation if, on the application to fix a fair rent, the Court is of opinion that the subletting was of 'a trivial character'. In order to remove doubts, the Land Act, 1896, section 7, defines 'trivial' to mean a subletting not exceeding one-eighth in value of the holding, exclusive of the buildings, provided the subletting took place before August 23, 1887. Lettings in conacre, agistment, and for the use of labourers are also, under certain conditions, excused.

(3) *Fixity of Tenure.*—The third great benefit of the Land Act is secured by 'the statutory term'. The effect of the creation of a statutory term is that for fifteen years the tenant cannot be disturbed in his holding except for breach of one of the statutory conditions. On the expiration of a statutory term the tenant has the right to have another statutory term fixed, and so on forever, so that he practically holds in perpetuity. A statutory term is created (1) by the fixing of a judicial rent by the Court in the case of present tenancies (sect. 8 (1)); (2) where the landlord demands an increase of rent and the tenant accedes to it; and this as regards both present and future tenancies (sect. 4); (3) by agreement filed in Court (sect. 8 (6), and Land Act, 1896, sect. 17); (4) by arbitration; and (5) by reinstatement of a tenant from whom possession has been taken (sect. 20 (2)). (See also Evicted Tenants Act, 1907.) It was provided by section 8 (7) that a further statutory term should not commence until the expiration of a preceding statutory term, and that an alteration of a judicial rent should not take place at less intervals than fifteen years. The Land Act, 1896, section 17, has, however, introduced sweeping changes as regards the statutory term. The parties may, by agreement, abridge the statutory term, fix a fair rent at any time, alter the duration of the term, consolidate, partition, or divide the holding, arrange for surrender of a portion of it, or agree to create a present tenancy.

The incidents of the statutory term are that the tenant holds under the six statutory conditions, viz. (1) that he shall pay his rent, (2) not commit persistent waste, (3) become bankrupt, (4) sublet or subdivide, (5) obstruct his landlord in the exercise of specified legal rights, (6) open a house for the sale of intoxicating liquors upon the holding. If the tenant commits a breach of one of the statutory conditions he is liable to ejectment, and he has no claim for disturbance. He may claim for improvements or, as is the more usual course, sell his interest, but in the hands of the purchaser the tenancy becomes, in effect, a future tenancy. Where the rent is unpaid the landlord's remedy is by ejectment for non-payment of rent; in case of breach of one of the other statutory conditions, by ejectment founded upon notice to quit. The landlord, in addition to the remedy under the statute, may, in a proper case, restrain the breach of a statutory condition by injunction (Steele *v.* Tiernan, 23 L.R.I. 583; Barton *v.* M'Fadden (1905), 1 I.R. 472). If the tenant tenders the rent due, or offers reasonable compensation to the landlord, proceedings will be stayed.

Future tenancies are tenancies (1) created after August 22, 1881, in holdings in which no tenancy subsisted on that date; (2) tenancies created in a holding after January 1, 1883, whether a tenancy did, or did not, exist in the holding on August 22, 1881; (3) tenancies created by the landlord where he has bought the interest of the outgoing tenant in open competition in the market or by agreement with the tenant, and not in the exercise of his right of pre-emption; (4) tenancies which, although originally present tenancies, have been sold in consequence of a breach of a statutory condition (sect. 13). The future tenant is protected against an arbitrary increase of the rent. If the landlord demands an increase of rent and the tenant agrees to pay it, the rent cannot be altered for fifteen years. If the tenant refuses, he may sell his interest, at the increased rent, but the landlord must pay the depreciation in the selling price caused by reason of such increase and the costs of the sale; or the tenant may allow the landlord to evict him, in which case he will be entitled to compensation for disturbance and improvements. It has already been pointed out that under the Land Act, 1896, section 17, the parties may agree to treat a future tenancy as a present tenancy.

Leaseholds.—The 21st section of the Land Act, 1881, enacted that leaseholds should continue in force notwithstanding the passing of the Act, provided that at the expiration of such existing leases as shall expire within sixty years after the passing of the Act the lessee, if *bona fide* in occupation, shall be deemed to be a present ordinary tenant from year to year, and may therefore apply to have a fair rent fixed. A lessee for his own life was held to be in *bona fide* occupation 'at the expiration of the lease', and his representatives had a right to have a fair rent fixed (Roe *v.* Cooney, 18 L.R.I. 243). The Land Act, 1887, section 1, conferred further benefits upon 'present leases', *i.e.* leases existing at the date of the passing of the Land Act,

1881. The section applies to leases which have not longer to run from the date of the passing of the Land Act, 1881, than a period of ninety-nine years, or for lives with a concurrent term of ninety-nine years, or for lives with a reversionary term not exceeding thirty-one years. It enables the lessee to apply during the currency of the lease to have a judicial rent fixed. The fixing of the fair rent attracts the statutory conditions, and any covenants in the lease inconsistent with the statutory conditions are void. Thus a covenant against alienation disappears (Smyth *v.* Moore, 32 L.R.I. 129) as being opposed to the right of sale. The covenants in the lease which are not inconsistent with the Land Acts remain in force. It is a matter of some doubt what these covenants are. It has been held (M'Evoy *v.* M'Evoy (1897), I.R. 285) that where a lease for lives is limited to heirs, the order fixing the fair rent makes it devolve as personalty. The tenant cannot sublet even by way of mortgage.

The next step in favour of leaseholders was taken by the Redemption of Rent Act, 1891. This statute enacted that where a lessee holds for a period which will not expire within the limits prescribed by the Act of 1887, under covenant for renewal or in perpetuity or under a fee-farm grant, he may apply to redeem his rent; and if the landlord does not, within two months, accede to the request, the lessee may have a fair rent fixed in the same manner as if he were within the terms of section 1 of the Act of 1887.

The term 'fee-farm grant' requires some explanation, which may be shortly given. (1) There might be a fee-farm grant at common law which meant a grant of the lands in fee simple subject to a rent. Inasmuch as there was no reversion the relation of landlord and tenant did not exist, and the grantor had only a personal remedy for the recovery of the rent. (2) Leases for lives or years renewable for ever were very common in Ireland, and in order to remedy certain inconveniencies the Renewable Leasehold Conversion Act, 1849, was passed, which enabled lessees in perpetuity to compel their landlords to execute a fee-farm grant which practically embodies the terms of the lease and preserves the relation of landlord and tenant notwithstanding the statute *Quia Emptores* (18 Edw. I), which prohibits subinfeudation; it applies to Ireland, being prior to Poyning's Law. (3) Grants in fee simple subject to a rent made since January 1, 1861. Under Deasy's Act, section 3, no reversion is necessary; the matter depends upon contract, and the relation of landlord and tenant, if such was the intention of the parties, was thereby created. It was held in Kelly *v.* Rattey, 32 L.R.I. 445, that the Land Acts being *in pari materia* only applied to cases in which the relation of landlord and tenant existed *by law*, and that therefore while the second and third kinds of fee-farm grants were within the Redemption of Rent Act, 1891, the first was excluded. The Land Act, 1896, section 14, brings holders of a fee-farm grant at common law within the provisions of the Redemption of Rent Act, 1891.

The Land Acts, 1888 and 1889, deal with assignees of leases who have not obtained the consent of the landlord in the manner prescribed by Deasy's Act, section 10. It was decided (Donoughmore *v.* Forrest, I.R. 5 C.L. 445) that a landlord who had not given his consent to the assignment in the manner prescribed by the Act, viz. by becoming a party to the instrument of assignment, or endorsing his consent on the instrument, was not bound by a verbal or written consent to the assignment, and that the receipt of rent was not an estoppel (Gillman *v.* Murphy, I.R. 6 C.L. 34). Such tenants did not hold as legal assignees, and were therefore excluded from the benefits of the Act of 1887. The Act of 1888 enables such assignees to have fair rents fixed. The Act of 1889 deals with leases made between June 1, 1826, and May 1, 1832, into which leases there is imported by law a covenant against alienation and subletting unless there is an express provision to the contrary. It must be proved that the landlord, by receipt of rent or otherwise, has consented to the assignment. Similar relaxations as to subletting are contained in the Land Act, 1896, section 11 (7 Geo. IV, c. 29, repealed by 2 Will. IV, c. 11, except as to leases made between June 1, 1826, and May 1, 1832).

Middlemen cannot have a fair rent fixed inasmuch as they are not in occupation. But the sub-tenants may have a fair rent fixed against the middleman. If the interest of the middleman expires (Land Act, 1881, sect. 15) or is determined by eviction (Land Act, 1896, sect. 12), or if the rent payable to the middleman is reduced below the rent payable by the middleman, and the latter exercises his right to surrender (Land Act, 1887, sect. 8), the sub-tenants become tenants of the superior landlord upon the terms of their former tenancies.

A tenant may exclude the application of the Acts by accepting a judicial lease, *i.e.* a lease for not less than thirty-one years, the terms of which are sanctioned by the Court. At the expiration of the lease a present ordinary tenancy exists, with, of course, the right to have a fair rent fixed (Land Act, 1881, sect. 10).

A tenant the aggregate of whose holdings amount to the annual value of £150 per annum may contract himself out of the Act (Land Act, 1881, sect. 22).

Even where the holdings are agricultural or pastoral, the Land Law Acts (as distinguished from the Land Purchase Acts, see below) do not apply to the following classes of holdings (Land Act, 1881, sect. 58, as amended by Land Act, 1896, sect. 5):—

(*a*) 'Residential holdings', *i.e.* where the main purpose of the letting is for residential purposes and the lands are only an adjunct to the house (Carr *v.* Nunn, I.R.R. and L.App. 89).

(*b*) Demesne lands, *i.e.* lands forming part of a landlord's demesne, and the circumstances show that the landlord reserved the power to resume possession of them (Griffin *v.* Taylor, 16 L.R.I. 197).

(*c*) Home farms, *i.e.* 'a farm to be used for the convenience or advantage of the landlord's residence and in connection therewith, and not merely as an ordinary farm, to be used for the

purpose of profit' (Hamilton *v.* Sharpe, 20 L.R.I., at p. 259).

(*d*) Town parks, *i.e.* lettings near a town, bearing an increased value as accommodation land, and occupied by a person living in the town (Land Act, 1870, sect. 15). A relaxation is contained in the Land Act, 1887, section 9, which allows a fair rent to be fixed upon a town park if it is let and used as an ordinary agricultural farm, and the fixing of a fair rent upon it will not interfere with the development of the town. The Land Act, 1896, section 6, extends the word 'agricultural' to include 'pastoral'.

(*e*) Pasture holdings (other than dairy farms) of the rateable value of £100 per annum, and pasture farms, of any rateable value, on which the tenant does not reside, unless they are used in connection with or adjoin his holding (Land Act, 1870, sect. 15; Land Act, 1881, sect. 58, as amended by Land Act, 1896, sect. 5).

(*f*) Conacre (a licence to take a crop off the lands, but not a letting of the lands), labourers' holdings, small cottage allotments, glebe lands, and temporary lettings, the purpose of the letting being expressed in writing.

The Town Tenants Act, 1906.—This statute extends the principle of the Land Act, 1870, to tenants other than agricultural. (1) A tenant, on quitting his holding, may claim compensation from his landlord for improvements, made by himself or his predecessors in title, which add to the letting value at the time of making the claim, and are suitable to the holding, and have not diminished the letting value of other property of the same landlord. The tenant, however, has no claim if the improvements have been made (*a*) for valuable consideration; (*b*) in contravention of a contract not to make them; (*c*) before December 31, 1906 (*quære* whether the date may not be held to be December 21, 1906), and are ten years old at the date of making the claim, except as regards permanent buildings; (*d*) if the tenant has entered into a reasonable contract not to make them; or (*e*) if the landlord has undertaken to make them and has not been guilty of unreasonable delay. Where the tenant proposes to make improvements after December 31, 1906, he must first give notice to his landlord. If the landlord objects, the matter will be determined by the Court. The landlord may, even after objection, execute the improvements himself, and will be entitled to charge a percentage, recoverable as rent, upon the outlay. The tenant has no claim in case of lettings for temporary convenience, or during his continuance in any office, appointment, or employment; but in such cases, if the letting was made after December 31, 1908, the purpose of the letting must be in writing. If the tenant is quitting his holding voluntarily, he will have no claim if the landlord offers to renew his tenancy, and at the same time gives him permission to dispose of his interest in the holding (sects. 1 to 4).

(2) Compensation for disturbance is given where a landlord, 'without good and sufficient cause' (Herron *v.* O'Donnell, 42 I.L.T.R. 227), terminates or refuses to grant a renewal of the tenancy, or it is proved that an increase of rent is demanded from the tenant as the result of improvements which have been effected by him. In such cases the tenant has the right to claim compensation for the loss of goodwill and also the cost of the removal of his goods, implements, and stock, and this in addition to any claim he may have for improvements. The tenant cannot claim for disturbance if he is evicted for breach of a condition of the tenancy, or if he is quitting voluntarily, or if he refuses to pay an increase of rent and the demand has not been made as a consequence of improvements executed by him and for which the landlord has not compensated him directly or indirectly, or if he holds by virtue of a temporary office or employment; but, as in the case of improvements, the purpose of such letting must, if made after December 31, 1906, be expressed in writing.

(3) Some differences under the statute must be noted between compensation for improvements and compensation for disturbance. (*a*) Compensation for improvements applies only to houses, shops, and other buildings situate in 'urban districts, towns, or villages', and occupied either for residential or for business purposes, or partly for residential and partly for business purposes (sect. 17); while compensation for disturbances applies to houses, shops, and other buildings occupied wholly or to a substantial extent for trade or business purposes (sect. 5 (2)). (*b*) Section 17, on the wording, is confined to compensation for improvements; it would therefore appear that compensation for disturbance may be claimed in respect of a business house although not situate in an urban district, town, or village — say, a country shop. (*c*) 'Tenant' for the purpose of the Act is defined as 'a person entitled in actual possession of the holding under any contract of tenancy for a year or for any longer period' (sect. 18). But, as regards compensation for disturbance, claims are specially restricted to cases where the premises are held under (*a*) tenancies from year to year created after the passing of the Act; (*b*) leases made after the passing of the Act for terms of less than thirty-one years, or for a life or lives; or (*c*) contracts of tenancy existing at the passing of the Act where the rent is under £100 per annum. Some of the sections of the Land Act, 1870, are incorporated in the Town Tenants Act as regards procedure and proof of improvements.

LAND PURCHASE

Land Purchase from 1870 to 1891.—Land purchase begins with the purchase sections of the Land Act, 1870 (commonly called the Bright Clauses), and the Glebe Loans (Ir.) Act, 1870. Under the former Act, tenants of agricultural or pastoral holdings, and under the latter, tenants of lands vested in the Church Temporalities Commissioners under the Church Disestablishment Act, 1869, could obtain loans, under certain conditions, from the Board of Works to assist them in the purchase of their holdings. The Land Commission was established by the Land Act, 1881, with judicial functions as to land law. The property formerly vested in the Church Temporalities Commissioners was transferred to the Church Property Department of

the Land Commission, and powers were given to make advances for the purchase of holdings, or the Land Commission might buy an estate for re-sale to the tenants. There were, however, various defects in the working of these purchase provisions. Where the owner agreed to sell the holding, the Land Commission could not advance more than three-fourths of the purchase money, the holding was transferred to the tenant by an ordinary conveyance, and incumbrancers on the owner's estate were required to consent to the execution of the instrument. The Land Purchase Act, 1885, altered the whole system, and may be regarded as the real commencement of land purchase. The Land Commission was empowered to advance the whole of the purchase money, which was to be repayable by the tenant by a 'purchase annuity' payable to the Land Commission. In order to protect the Land Commission against loss, a guarantee deposit was required to be provided, amounting to one-fifth of the purchase money, and to be lodged with the Land Commission. In practice the owner consented to the retention of the guarantee deposit out of the purchase money. Interest is payable on such guarantee deposits at the rate of 2¾ per cent, and they may be transferred. If the tenant falls into arrear with his instalments, and the Land Commission declares the debt to be irrecoverable, the loss may be made good out of the deposit. When the purchaser has paid by means of his instalments one-fifth of the purchase money, the guarantee deposit must be paid to the person then entitled to it. The lands were vested in the tenant by a vesting order of the Land Commission, under which they are held free from the claims of incumbrancers, &c., which are transferred to the purchase-money, and, to prevent delays in sales, the purchaser takes them subject to the rights of adjoining tenants or owners as regards *easements*, *profits à prendre*, or other claims of like nature. The vesting order vests the estate in fee simple in the purchaser, but subject to all trusts affecting him in his former estate, whether as a yearly tenant or a leaseholder. For instance, if he held a tenancy from year to year as administrator of his deceased father, and his brothers and sisters had not been paid their distributive shares, the fee simple acquired under the vesting order would remain bound; in the phrase commonly employed by Irish lawyers it is subject to the doctrine of 'graft' (Land Act, 1885, sect. 8; Land Act, 1887, sect. 14 (5)).

This Act and a short amending Act passed in 1888 are known as the Ashbourne Acts. The Land Act, 1887, contains provisions as to land purchase, but chiefly regarding matters of procedure beyond the scope of this article.

Land Purchase between 1891 and 1903.—The sum of £10,000,000 provided by the two Ashbourne Acts was exhausted, and the Land Purchase Act, 1891 (the Balfour Act), was passed. This statute, and the land purchase provisions of the Land Act, 1896 (a statute already noticed as regards its amendments of land law), are largely of an administrative and financial character. The main changes in respect of land purchase may be pointed out. The purchase annuity was still to begin at 4 per cent per annum, but was to be reduced at decennial periods for the first three decades. The period of redemption was much extended, but the interest became lower, especially after thirty years. Purchasers under the Ashbourne Acts have also been enabled to have their term of repayment to the Land Commission extended, and the great majority of them have elected to pay the lower interest for the longer period. The purchase annuity may be redeemed at any time by payment in cash. The guarantee deposit also might be dispensed with, or if already made, may be released, if the holding is a sufficient security (Land Act, 1896, sect. 29). Purchase under the Acts does not operate to convert the interest of the purchaser into real estate (Land Act, 1896, sect. 32 (4)); *e.g.* if a tenant from year to year purchases under the Acts and dies intestate, his holding devolves as personal property and does not belong to the heir-at-law. Under the Land Purchase Act, 1891, the price was paid to the owner in guaranteed land stock at 2¾ per cent, and not in cash as under the earlier Acts.

The '40th section' of the Land Act, 1896, requires a brief notice. The Land Judge's Court was intended in its inception for the sale of incumbered estates—but buyers were not forthcoming, and, as a consequence, the estates were necessarily kept in the Court and the rents collected through receivers. Where the Land Judge has made an absolute order for sale of an agricultural or pastoral estate, or where a receiver has been appointed, the first offer of sale must be made to the tenants in occupation as being the only likely purchasers (Land Act, 1896, sect. 40, Owen's estate (1897), 1 I.R. 186).

The Redemption of Rent Act, 1891, has been already dealt with in connection with the rent-fixing provisions under 'Land Law'.

Holdings bought under the Land Purchase Acts must be registered under the Local Registration of Title Act, 1891, and kept so registered as long as any instalment of the purchase annuity is unpaid. The legal estate in registered lands devolves upon the personal representatives notwithstanding any testamentary disposition. The registration may be free from equities, *i.e.* as absolute owner, or subject to equities. In the latter case the equities may be discharged to the satisfaction of the registering authority.

Land Purchase since 1903.—The Land Act, 1903 (the Wyndham Act), starts with the principle that land purchase is to progress not by sales of holdings but by sales of 'estates'. A new department of the Land Commission has been constituted, styled 'the Estates Commissioners', and to this body is entrusted practically the whole working of the Act under sections 1 to 23. Before the provisions of the Act can be applied, the Estates Commissioners must declare that the lands to be sold constitute an 'estate' within the meaning of the Act (sect. 98 (1)) (Weir's estate, 42 I.L.T.R. 35). A portion of an estate, or a group of holdings on an estate, or even a single holding, may, if the Estates Commissioners think fit, be declared to be a 'separate estate'. The Act, following the prin-

ciple of the previous Land Purchase Acts, applies only to estates which are in the main agricultural or pastoral (Land Act, 1903, sect. 10). But holdings exempted from the land law portions of the Acts (Land Act, 1881, sect. 58, and Land Act, 1896, sect. 5), such as demesne lands, town parks, &c., may be bought under the Land Purchase Acts. An 'estate' may include untenanted lands, and even buildings not agricultural in character (King Harman's estate, 38 I.L.T.R. 257). Sales may be (1) direct sales by owners to tenants and others; (2) the Estates Commissioners may purchase an estate for re-sale to the tenants or others; and (3) the Estates Commissioners may purchase an estate which is for sale in the Land Judge's Court, for the purpose of re-sale. Sales direct by the owner to the tenants and others are, of course, by far the more usual. When the terms of sale between the parties have been agreed upon, and the Estates Commissioners decide that the subject matter of the sale is an 'estate' or 'separate estate', an originating application is submitted to the Estates Commissioners containing the prescribed particulars, maps, &c. In the case of judicial tenancies the Commissioners must sanction the advance where the purchase annuity under the Act, as compared with the rent previously payable by the tenant, falls within certain limits—popularly known as 'the zones'. These limits are: (*a*) where the judicial rent has been fixed since the passing of the Land Act, 1896 (August 15, 1896), if the purchase annuity under the Act will be not less than 10 per cent nor more than 30 per cent below the existing rent; (*b*) where fixed before that date, if the purchase annuity will be not less than 20, nor more than 40 per cent below the rent. The explanation of the difference in scale is that 'second term rents' are, almost invariably, lower than 'first term rents'. But if the purchase agreement so provides, the Commissioners may treat a judicial rent fixed before August 15, 1896, as being a judicial rent fixed since that date (Land Act, 1903, sect. 1). In the case of judicial tenancies where the purchase annuity is not within the zones (sect. 1 (2)), and in cases other than judicial tenancies (sect. 5), the Commissioners may sanction the advance if they are satisfied with the security. 'Owner' for the purposes of the Act has a very wide meaning. The term includes limited owners. A person who gives prima facie evidence that he is a person having power of sale under the Act, and that for six years he, or his immediate predecessor in title, has been in receipt of the rents and profits, may be dealt with as owner for all purposes except the distribution of the purchase money (Land Act, 1903, sect. 17). The Land Commission vest the lands in the purchasers, and pay the purchase money into the Bank of Ireland, and an order is made attaching all claims against the owner—*e.g.* quit rent, crown rent, head rent, family charges, mortgages, &c.—to the purchase money as representing the estate.

In order to promote the sale of lands, a 'purchase in aid fund' is established whereby a percentage of 12 per cent upon the amount of purchase money was payable to the vendor (sect. 48). Doubts arose as to the destination of this percentage (known as the 'bonus') where the vendor is a limited owner (Ely's estate (1904), 1 I.R. 66). An amending Act was passed in 1904 giving the 'bonus' to the tenant for life for his own benefit, unless where the estate is insolvent or is sold by the Land Judge. Section 48 (3) provided that this 'bonus' might be reduced by quinquennial revision. By Treasury order, dated November 22, 1908, the 'bonus' is reduced to 3 per cent as regards future sales.

Prior to 1891 the purchaser was required to show that he was an occupying tenant. Advances may now be made (Land Act, 1903, sect. 2) (*a*) to a tenant in occupation; (*b*) a son of such tenant; (*c*) a tenant or proprietor of a holding not exceeding £5 in rateable value situate in the neighbourhood of the estate; (*d*) a person who within twenty-five years was a tenant of a holding to which the Land Acts apply, and who is not at the date of the purchase the proprietor of that holding. A considerable number of evicted tenants—'the wounded soldiers of the land war'—have been reinstated under paragraph (*d*), and by section 12 the Land Commission may execute such works as may be necessary for the improvement of untenanted land, or may assist the purchaser in restocking it. A still further step in favour of the evicted tenants has been taken by the Evicted Tenants Act, 1907 (as amended by the Act of 1908).

The purchase annuity in the case of estates sold under the Act of 1903 is £3, 5*s*. per cent per annum during a period of sixty-eight and a half years. The guarantee deposit is abolished as to sales taking place under this Act, and the price of the estate is paid in cash. If the proprietor of a holding sublets or subdivides it, or if the title of the proprietor is divested by bankruptcy, the Land Commission may cause the holding to be sold. If, on the decease of a proprietor, the holding would, by devise, bequest, intestacy, or otherwise, become subdivided or vested in more than one person, the Land Commission may either cause it to be sold, or nominate some person interested in the holding to be the proprietor subject to the claims of other persons interested. The proprietor may not mortgage or charge the holding, or part thereof, for any sum exceeding ten times the amount of the purchase annuity payable in respect of the holding or part upon the making of the advance. Sales by the owner to the Land Commission with a view to re-sale are governed by sections 6 and 8. The owner lodges an originating request. The Estates Commissioners enquire into the circumstances of the estate, and the prices which the tenants and other persons are willing to give for the holdings and other parcels of land comprised in the estate. The Land Commission may then make a proposal to the owner, and if he agrees to sell at the estimated price, and three-fourths in number and rateable value of the tenants undertake to buy their holdings, the Land Commission may agree to purchase the estate, and may compel the remaining tenants to purchase their holdings.

The Land Commission, where an estate is fcr

sale in the Land Judge's Court, may make an offer to purchase for the purpose of re-sale. If the offer is accepted, the order of the Land Judge vests in the Land Commission all rights to collect arrears of rent specified in the order. If the Land Judge thinks the offer insufficient, the estate must be put up for public auction. Where the Land Commission makes an offer, the operation of the '40th section' of the Land Act, 1896, is suspended until the offer is withdrawn or the property is put up for auction and not sold (Land Act, 1903, sect. 7). Where an owner sells an estate to the Commissioners, he may purchase his demesne and other lands, and an advance not exceeding one-third of the purchase-money or £20,000, whichever is the less, may be made to him by the Land Commission for this purpose. There are two advantages to the owner: (1) he gets a considerable additional fund in hand wherewith to pay off incumbrances, often bearing a high rate of interest; and (2) he acquires a new root of title to the property.

When the purchase money has been paid into the Bank of Ireland, the person or persons claiming it must establish their title. Even where the vendor is an owner in fee simple there will be the questions as to the apportionment or redemption of quit rent, crown rent, tithes of various kinds, head rent, mortgages and other incumbrances, family charges, &c. The Land Commission adjudicates upon all these claims, which must be cleared off before the balance of the purchase money is paid out. Pending the determination of these matters, interest is paid on the amount of the purchase money, generally at the rate of 3½ per cent; and out of the amount so paid, the owner must pay the interest upon the mortgages, &c., which have not yet been allocated. Such interest is, as a rule, higher than 3½ per cent, so that it is in the owner's interest to have the matter 'closed'.

The Congested Districts Board.—With a view to the improvement of 'congested districts', this Board was constituted by the Land Purchase Act, 1891, and a grant was made to the Board of £1,500,000, with interest at the rate of 2¾ per cent charged on the Church Surplus Fund (temporalities of the Disestablished Church). Amending Acts have been passed (in 1894; the Land Act, 1896, part iv; 1899; 1901, No. 1 and No. 2; and the Land Purchase Act, 1903, part ii) conferring upon the Board large powers as to the purchase and re-sale of lands within the defined districts. A 'congested district' means an estate not less than half the area of which consists of holdings not exceeding £5 in rateable value, or of mountain or bog land, or not less than a quarter of which is held in rundale or intermixed plots. The Congested Districts Board has rendered inestimable service to Ireland, not only by the amalgamation of small holdings and the purchase and re-sale of lands for the purpose of adding to small and uneconomic farms, but also by administering the funds placed at their disposal in the development of agriculture, the improvement of the breed of cattle, poultry raising, beekeeping, fishing, weaving, spinning, and other industries within the districts scheduled as congested. Full information will be found in the annual reports of the Board. [C. M.]

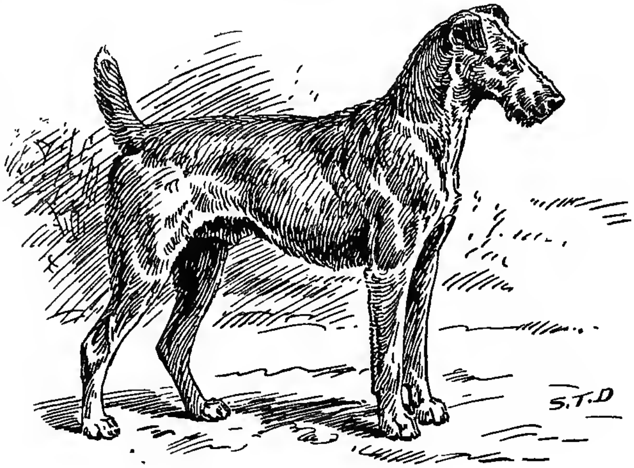
Irish Pigs.—In connection with dairying, the breeding and fattening of pigs has for many years been an important industry in Ireland. It may be, as claimed, that Irishmen have a special aptitude in the management of stock, especially of pigs; but there can be no doubt that the production of the most palatable kind of bacon, for which the Irish curers have for long been noted, has only been possible through the small farmers in Ireland providing a pretty constant supply of fat pigs, which have been rendered especially suitable for the purpose from having been fed to a large extent on dairy bye-products. The old-fashioned long-legged, flat-sided, hungry-looking Irish pig, like unto the American rail-splitter, has long since been eliminated. Its place was at first taken by long and deep-sided pigs with well-developed hams, the result of a cross with boars of the old-fashioned Berkshire type. This cross was less successful when the American style of Berkshire pig (black with white points) became fashionable, some thirty or forty years ago. After this, the Large White or large-sized Yorkshire boar was extensively used, with the best possible results wherever the boars imported were from herds which were managed with a view to success not so much in the show yards as in the commercial world. At a later period, politics, and the cry of Ireland for the Irish, appeared to have an influence even on pig breeding. It was contended that the large amount of money provided by the Government for the increase of stud animals for the use of small farmers at low-service fees should be expended at home instead of being sent across the Irish Sea in exchange for English-bred boars. Attempts have been made to comply with this characteristic demand, and very probably one of the outcomes of it has been the formation of pig societies or herd books in connection with the Royal Dublin and the Royal Ulster agricultural societies. The state of affairs in Ireland might be cited as an excuse for this unfortunate desire for the exclusion of the most suitable male animals for the improvement of Irish stock; but a doubt may arise in the minds of disinterested persons as to the wisdom or even the necessity of an attempt to run two herd books in Ireland in addition to that of the National Pig Breeders' Association, which deals with Large White pigs. The probable cause for this unfortunate rivalry may be on the surface, still the untoward results are not lessened but rather increased. Surely it would have been more to the advantage of Irish pig breeders and bacon curers if the efforts of all had been concentrated on the production of a native breed of pigs best suited for the purpose, rather than on an attempt to form two different types of local pigs, especially when no particular original district type exists. The results of the experiments may possibly be soothing to local prejudices for a time, but they cannot eventually prove of so great permanent benefit to Irishmen as would have resulted from taking pigs of a breed best

suited to the dairy farmer and the bacon curer, and then by selection rendering them especially capable of supplying all or any local requirements. Where an attempt is made to run a herd book in a locality of a limited area, there is a danger of those responsible for drawing up a scale of points studying the peculiarities of the breed rather than the commercial requirements of the general body of consumers; for instance, the scale of the so-called Large Ulster pig assigns six points to the 'ears, which should be long, thin, and inclined well over the face', and then under the heading 'Coat, small quantity of fine silky hair', ten points are mentioned, so that we have about one-sixth of the points of a bacon curer's pig accorded to mere fancy points. Further, it is at least a moot point if bacon curers and practical pig breeders would not look with some suspicion on a pig possessing only a 'small quantity of hair', since the general view is that pigs with plenty of fine hair are more hardy, and also produce a larger proportion of lean meat, than sparsely haired pigs. The great change of late years in Cumberland pigs is a case in point. Another failing of local fanciers is to value too highly mere size. The typical Large White Ulster pig is long in the leg and heavy in bone, whereas the bacon curer and the consumer of both cured and fresh pork asks for as little bone and as much lean meat as possible. The mere fact that it is publicly stated that a greater quantity of bacon is imported into Ireland than is exported, clearly proves that it is imperative that some concentrated and sustained efforts should be made by Irish patriots to increase the number of pigs kept, and to improve their general style, character, and quality. [s. s.]

Irish Terrier.—A little more than a generation ago the Irish Terrier was scarcely recognized as a distinct breed, but now he is one of the most popular varieties of the day, and is held in high favour in every part of the world. Moreover, as is not always the case in connection with fashionable breeds of dogs, the Irish Terrier most thoroughly deserves the position he occupies, as he is a hardy, handsome, hard-bitten dog, full of life, and a first-rate hunter of all sorts of vermin. In fact, for those in search of a rough-coated terrier for companionship and working purposes, he knows few superiors, and hence it is not in the least degree surprising that his popularity increases year by year.

Regarding the history of the variety there is not much to be said, as, although his lineage may be ancient, it is shrouded in obscurity, though broken-haired, sporting-looking terriers have always been common enough in Ireland. Towards the end of the 'seventies, however, a few gentlemen who were interested in dog shows, amongst whom the late Mr. W. Graham of Belfast and the late Mr. G. R. Krehl of London were very prominent, took the breed well in hand, and, thanks in no small measure to their influence, the merits of the improved Irish Terrier were brought before the public. It is a first-rate sporting dog, singularly active, and as it is a little inclined to be high on the leg and of a rather lathy build, it is a capital companion for equestrians who enjoy the society of a smart terrier when indulging in their country rides.

The head of the Irish Terrier should be of considerable length, but though heaviness is regarded as a serious fault, any signs of weakness about it are likewise objectionable. In fact, the head, which should be flat on the top, should taper gradually towards the muzzle, but



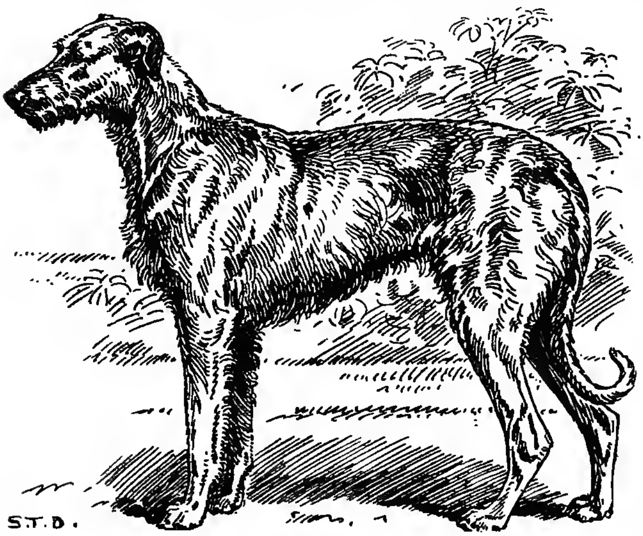
Irish Terrier

the latter must be powerful, and well filled in under the eyes, a weak jaw being a bad fault in a dog of this breed. The teeth should be quite level, the nose black, and the eyes rather small and sunken (as the Irishman is a terrier all over) and of a dark hazel colour, a yellow eye being a most unsightly blemish. A rather long neck, perfectly free from any tendency towards coarseness, is another feature of the breed, whilst the shoulders should be long and well laid back, and the chest deep rather than narrow, for the Irish Terrier is a speedy mover, and a wide chest would be against the development of pace. The ribs are nicely sprung and the loins are powerful, the back being nice and flat, with plenty of muscle but with no extraneous lumber, which would interfere with the dog's activity. The fore legs are a little longer than those of most terriers, but they must be absolutely straight, and set on well under the dog, any tendency towards being out at the elbow or bent at the pasterns being a bad fault; whilst the feet should be compact, and with well-developed knuckles. The hind quarters are muscular, and there is a good length between the stifle and hock joints, whilst the tail is always docked.

The coat must be harsh and weather-resisting, very wiry in texture above and close below; but it must not be too long, woolly, or straggling, and if the last-mentioned fault appears, it will be beneficial to cross with a smooth-haired specimen of the breed, such as can often be found. The favourite colour is a deep yellowish-red, of even shade all through, though much paler shades are sometimes seen; but these are not liked, though they might be tolerated in the case of a good dog. The weight is about 18 lb. to 20 lb. [v. s.]

Irish Tobacco Act. See TOBACCO ACT.

Irish Wolfhound. — Picturesque in appearance though this dog undoubtedly is, there can be no denying the fact that the name conferred upon him is entirely a misnomer, as he possesses no trace of the ancient and extinct Irish Wolfhound in his composition. The latter breed had died out by the end of the 'seventies, the last known specimen of the breed being an animal which had been kept for some years in the Dublin Zoological Gardens, and then some enthusiasts set themselves to work to produce a successor to the extinct Irish Wolfhound. This they accomplished by crossing the Scottish Deerhound with the German Great Dane, availing themselves of the services of the former to acquire the desired shape and coat, and of the latter to procure the size they wanted. There being no mystery at all regarding the proceedings of these gentlemen, it is a little surprising, and perhaps ridiculous, that the new creation should be described as an Irish Wolfhound, but its appearance is highly creditable to the efforts of those who brought it into existence, though their Teutonic ancestry is clearly proved in the case of many specimens of the breed, by the thickness and shape of their skulls. At the same time the originators of the new dog accomplished all they desired in the way of obtaining bulk and height, as the height and appearance of the variety produce a most imposing effect, and its admirers are concentrating all their energies in adding still further to its stature. A height of 32 in. and over has already been reached in several instances, and there can be little room for doubting that this will be increased, though it is probable that the extra inches will be obtained at the expense of bulk, as the limitations of nature have been very nearly reached. At the same time it may not be unreasonable to expect that exceptional animals will appear, and these will doubtless realize all the aspirations of their admirers. The general appearance of this dog is that of a gigantic Deerhound, and consequently the description of the latter breed applies to them, only every point must be magnified, the weight of the variety now under consideration averaging about 110 lb. [v. s.]



Irish Wolfhound

Iron. — This metal has been known from the earliest of historical times. Implements made of iron have been discovered in ruins many centuries B.C. Iron is occasionally found in the native state, but the following is a list of the principal iron ores. In the form of oxides it occurs as—red hæmatite, brown hæmatite, magnetite, and limonite. In other forms it exists as spathic iron ore, clay ironstone, and pyrites. The extraction of iron from its ores forms one of the staple industries of the British Isles, and indeed of many other countries. The purity, lustre, hardness, tensile strength, malleability, &c., of cast iron and steel depend on the method adopted in its purification and subsequent treatment. Very small quantities of the elements silicon, sulphur, phosphorus, carbon, manganese, chromium, &c., appreciably influence the physical properties and value of iron, hence the proportions of these bodies require to be regulated according to the desired circumstances.

Iron rusts in moist air. To prevent this rusting, various devices for excluding air from the surface of the iron are adopted, such as covering the metal with a thin coating of zinc or tin, or by the magnetic oxide. Painting, oiling, varnishing, &c., are also resorted to. The red rust is mostly the hydrated sesquioxide. This oxide, besides having other uses, is employed largely in red paints, pigments, &c. The earthy varieties of the oxide are called ochre, reddle or raddle. It forms the principal red colouring matter in rocks, soils, &c.

Besides the oxides, iron forms many other important compounds. Among those of agricultural importance is green vitriol or iron sulphate, used in spraying charlock. This compound likewise occasionally forms the injurious compound causing infertility in some soils. When present

in excessive quantities it acts as a plant poison. The addition of quicklime, however, renders the compound harmless. Iron is universally distributed throughout soils. It is a plant food, but most soils contain sufficient for the requirements of crops. Iron bacteria, capable of decomposing iron compounds, exist in almost all soils. Iron salts are soluble to an appreciable extent in solutions of vegetable matter. Spring waters containing iron salts are noted for their medicinal properties. [R. A. B.]

Iron Compounds in Soil.—These fall mainly into two groups, ferric and ferrous compounds, the former being fully oxidized, while the latter are not. Ferric compounds are unable to combine with any more oxygen, but will, under suitable conditions, give up some of their oxygen and become reduced to the ferrous state. Ferrous compounds, on the other hand, tend to take up oxygen and oxidize to the ferric state. The two sets of compounds are therefore to some extent interchangeable, and their relationship may be expressed thus:—

$$\text{ferrous compounds} + \text{oxygen} \rightleftarrows \text{ferric compounds},$$

the two arrows signifying that the change may go in either direction.

The amount of oxygen present determines the distribution of the two groups: ferrous compounds occur in stiff clay subsoils, where air cannot enter, and ferric compounds in well-aerated soils, where air readily penetrates. There is a great difference in colour: ferrous compounds are bluish-green or grey, while ferric are deep-red. The colour of the soil therefore shows the nature of the iron compounds, and indirectly shows also the ease with which air penetrates; a deep-red soil is necessarily well aerated, while a brownish soil lying on a greenish clay is aerated only in the uppermost layers.

Although all the compounds of iron known to occur in the soil are insoluble in water, there is some process, not completely understood, by which iron dissolves in the soil. All drainage water contains iron; at Rothamsted 3 to 8 parts of ferric oxide per million of water are found. Some deep-well waters contain distinct amounts, and on standing yield a brown ferruginous deposit. The dissolving out of iron from the soil is strikingly seen in sandy soils; here the quantity of iron present is not great (usually only 2 or 3 per cent), but it produces a considerable colouring effect by reason of the small amount of surface it has to cover; when it is dissolved out the soil becomes quite white. The action is best seen near plant roots; the layer of sand around the roots of trees is often white, and shows in sharp contrast with the yellow or red sand farther off. Similar results may be observed on heaths; just below the surface there is often found a white layer of sand or gravel from which most of the iron has been dissolved. We have already stated that the process by which the iron dissolves is not completely understood: it is commonly supposed that the ferric compound is reduced by the organic matter of the soil to ferrous carbonate, which then dissolves in the excess of carbonic acid to form a soluble bicarbonate just as chalk under the same circumstances will dissolve. The evidence is not, however, very clear, and further work is desirable.

Effect of Iron Compounds on Fertility.—Iron is essential for the growth of the plant, but the amount required is very small, and probably all soils contain sufficient for plant nutrition; there is no reason to suppose that the iron compounds in normal soils directly affect the plant one way or the other. But, as we have seen, the nature of the iron compounds depends on the supply of oxygen; ferric (*i.e.* red) compounds indicate good aeration, while ferrous (*i.e.* greenish) compounds indicate defective aeration. Ferric compounds are therefore one of the signs of a fertile soil. They also themselves contribute to fertility, but rather in virtue of their physical than of their chemical properties. They possess some of the properties of humus, but to a less extent; thus they absorb heat and help to warm the soil; they have also considerable power of retaining water; they modify the stickiness of clay, and so enable the soil to be worked more readily. Red soils are almost always noted for their fertility. They arise from at least three geological formations. The Keuper beds of the Upper Trias formation form rich land in Cumberland round Carlisle, in the North Riding of Yorkshire, parts of Cheshire, &c. The sandstones of the Permian formations are seen in Devon, Dumfries, Ayrshire, and elsewhere. The Old Red sandstone, especially the marls and cornstones, gives rise to some of the best soils in the British Isles in Hereford, Devonshire, Cornwall, and East Lothian districts; the potato soils of Dunbar lie on this formation. But it is not correct to suppose that the fertility can be gauged by the amount of iron present. Ashby (Journ. of Agric. Science, 1905, p. 350) analysed two potato soils from Dunbar, one yielding good-quality potatoes, the other yielding poor potatoes, and found substantially the same amounts of iron oxide in both, viz.:—

	Poor quality.	Good quality.
Surface soil ...	4·74	5·50 per cent of Fe_2O_3
Subsoil ...	4·18	3·40 ,,

The red clay capping the chalk round London and forming a rather poor soil contains 3 to 4 per cent of ferric oxide. This does not show the deep-red colour of the soils above mentioned, and there is clearly some difference in the nature of the iron compounds, but it is evident that the mere *amount* is no guide to fertility.

Ferrous compounds are a sign of defective aeration and therefore of infertility. They impart a green, blue, or grey colour to the subsoil, changing at the surface by weathering to brown. About 4 or 5 per cent is often present in clays, *e.g.* as in the Weald clays. One of them gives rise to a distinctly poisonous substance. Pyrites (see below) oxidizes to form ferrous sulphate and sulphuric acid, so that a basic sulphate is produced which is detrimental to vegetation. Voelcker (Jour. Royal Agric.

Soc. 1865, vol. i, Series 2, p. 117) gives three instances of barren soils which owe their sterility to this cause:—

	Reclaimed from Haarlem Lake, Holland.	Reclaimed on Hampshire Coast.	Sandy Beds.
Iron pyrites	0·71	0·78	0·56
Ferrous sulphate ...	0·74	1·39	1·05
Sulphuric acid combined as basic iron sulphate	1·08	—	—

All the soils were acid. Liming was found to counteract the injurious effect.

The Compounds found in the Soil.—Among the iron compounds occurring in the soil are: (1) The red oxide (Fe_2O_3), usually in a hydrated form, *i.e.* combined with a certain amount of water; (2) the black magnetic oxide (Fe_3O_4); (3) a compound soluble in carbonic acid, usually supposed to be ferrous carbonate ($FeCO_3$); (4) iron pyrites (FeS_2); (5) ferrous silicates; (6) ferric silicates.

The Red Oxide (Fe_2O_3).—The anhydrous form, hæmatite, is found in quantity in the carboniferous limestone of Cumberland, Lancashire, the Forest of Dean, and Llantrissant, in Glamorganshire, but is not widely distributed in the soil.

The hydrated form, limonite, forms the chief part of our native iron ore, and is extensively mined from the Jurassic rocks in Yorkshire (Cleveland Hills); it is also found in Lincolnshire (Middle Lias, also Lower Lias at Frodingham), Leicestershire (Middle Lias), Oxfordshire (Middle Lias), the Northampton sands, Wiltshire (Corallian rocks of Westbury). An impure form, known as bog iron ore, is found in marshes, &c. A pulverulent earthy form, yellow in colour and called ochre, is found in Anglesey, Oxfordshire (Shotover Hill), and Somerset (Winford). It is widely distributed, and occurs in practically all soils; in heavy undrained soils it forms the pan (see next art.). It may be red, yellow, or brown, is insoluble in pure water, but readily dissolves in acids. Reducing agents convert it into the ferrous state. It shows some of the properties of colloids; thus it retains water to a certain extent, and acts as a weak cementing material, *e.g.* it forms the cementing substance of certain sandstones.

There are two ways in which it may arise in the soil: (1) by weathering of complex iron silicates; (2) oxidation of ferrous carbonate, often associated with bacterial action. Certain bacteria, *Crenothrix polyspora*, *Cladothrix*, *Leptothrix ochracea*, can take up ferrous carbonate from its solution in carbonic acid and convert it into ferric oxide. The action is an oxidation and gives out heat. The physiological significance of the change is not yet settled. Winogradsky (Botanische Zeitung, 1888, vol. xlvi, p. 261) supposed that the organisms depend for their energy supply on this oxidation just as we depend on the oxidation of sugar, fat, &c. Molish (Die pflanze in ihren Beziehungen zum Eisen. Jena, 1892), on the other hand, considers that the action is not essential, and succeeded in growing *Leptothrix ochracea* for several generations without any iron. The organisms are surrounded by a gelatinous sheath through which the soluble matter in the water passes, but the insoluble iron compounds (deposited as the carbonic acid goes off) do not. The sheath, in fact, acts as a filter; the oxidation takes place outside the organism, and has nothing whatever to do with any vital process. It is not yet clear which view is correct. The action, however, is very well seen in the ditches in marshes and bogs, where the soluble ferrous compound is issuing forth into the air; the red slimy streaks are great masses of these organisms retaining the iron. It only goes on in acid soils, and is a characteristic indication of the absence of calcium carbonate. Occasionally the organisms cause great trouble by developing in water supply pipes and causing stoppage.

The magnetic oxide (Fe_3O_4) is found at Hey Tor (Devonshire) and Rosedale (Yorkshire): it gives the black colour to certain soils on the Pacific coast of the United States (Hilgard), and to some of the black cotton soils of India (Annett). It is easily recognized because it is attracted by a magnet; so far as is known, it is without effect on productiveness, excepting in so far as its black colour helps to warm the soil. It does not occur to any extent in British soils.

Ferrous carbonate occurs in a fairly pure state as spathose iron ore in the Morte slates of the Brendon Hills and the carboniferous rocks of Weardale (Durham); in an impure state as clay ironstone and as blackband ironstone in the coal measures. It occurs in the deposit from ferruginous waters, and is considered to be the soluble iron compound of the soil. It is supposed to arise when ferric compounds are reduced in the soil by organic matter in absence of oxygen. The non-crystalline form easily absorbs oxygen, and is converted into ferric oxide; the crystals are more resistant.

Iron pyrites (FeS_2) forms yellow crystals, well seen in coal; it also occurs in a finely divided state disseminated through certain clays and shales. Another form, marcasite, forms fibrous masses in clays, especially the London Clay, and also occurs in hard round balls in the chalk, commonly supposed by uneducated persons to be 'thunderbolts'; on breaking one of these balls the fibrous structure is very beautifully seen. On oxidation it changes to ferrous sulphate and sulphuric acid, which, as pointed out above, adversely affect fertility unless lime is added. *Iron silicates* are described under Silicates. See Iron Pyrites.

[E. J. R.]

Iron-pan.—An iron-pan may be defined as an indurated layer of the soil or subsoil, consisting of the ordinary soil-particles closely cemented together by the hydrated oxide of iron known as limonite or bog iron ore. Iron-pans are not of very common occurrence, but are confined chiefly to moory or vegetable soils that are well supplied with ferruginous mine-

rals. The iron-bearing constituents of these soils are readily attacked by the carbonic acid produced by the decay of the organic matter which the soil contains, and the iron is leached out in the form of iron carbonate, this salt, like the analogous lime compound, being easily soluble in water containing carbonic acid gas in solution. When the soil-water in which the carbonate is dissolved percolates through the soil and comes into contact with air in a looser substratum, the dissolved gas escapes, precipitating the carbonate of iron, which becomes eventually oxidized to limonite. In this form it effectually binds together the soil-particles of the zone in which it appears. The leaching-out process is, no doubt, aided by certain humous substances of the soil, some of which remain associated with the iron deposit, imparting to the pan its well-known dark-brown tint. Iron-pans act injuriously by opposing a serious barrier to the passage of the roots of plants, and to the free movement of soil-water both upwards and downwards. The best remedial measure to adopt is the application of a liberal dressing of lime to the land; this causes the gradual disappearance of the pan, and at the same time furnishes a much-needed fertilizing ingredient. Breaking up the pan with the subsoil plough is also to be recommended. [T. H.]

Iron Pyrites.—Two closely allied minerals are included under this general name, both consisting of iron disulphide (FeS_2). By far the more common one is *Pyrite*, generally known as Iron Pyrites, a brass-yellow metallic mineral crystallizing in the cubic system. Commonly it assumes the form of cubes or other highly symmetrical and allied figures, such as a form bounded by twelve pentagons. The cubes show striæ on their surfaces which are perpendicular to one another on adjacent faces, and thus indicate that the mineral falls short of the highest cubic symmetry. A very important character is that pyrite cannot be scratched by a knife; it is brittle, yielding an almost black powder when finely crushed; and it gives off sulphur freely when heated in a small glass tube over a gas flame. Copper pyrites (sulphide of copper and iron), a far more valuable substance when occurring in good quantity, can be scratched by a knife, and gives chemical reactions for copper. Gold, for which pyrite is frequently mistaken, is far heavier than either of the above-mentioned sulphides, is malleable and sectile, and of course yields no sulphur.

The common occurrence of pyrite in crystals renders its recognition easy. These often arise in altered slaty rocks which have been baked by igneous masses, and the mineral is sometimes picked up on the surface of the land. It oxidizes into brown limonite, losing its sulphur, but often retaining its crystalline form.

The second mineral included under Iron Pyrites is *Marcasite*, crystallizing in the rhombic system, but otherwise much like pyrite, and of the same hardness. Marcasite, when cleaned with hydrochloric acid, is seen to be tin-white, but it soon assumes a pale brassy tarnish. Fossil shells are often replaced by marcasite, and both this mineral and pyrite form concretionary and radial nodules in many rocks. These nodules, brown on the outside and brassy within, are often found in the Chalk and in the flint gravels derived from its decay, and are commonly regarded as 'thunderbolts'. They are, however, purely of terrestrial origin.

Iron Pyrites, giving rise as it does to sulphate of iron during decomposition, is a very dangerous constituent in a soil. So destructive is it to vegetation, that crushed pyrites has been successfully employed in the making of garden paths, which in time turn slightly brown, but even then require no scuffling for the removal of weeds. Where heavy rainstorms, however, splash water from these paths on to adjacent grass, the latter withers away. [G. A. J. C.]

Iron Silicates. See SILICATES.

Ironstone.—This term is used for any heavy rock or massive mineral rich in iron; but the majority of ironstones are, or have been at one time, formed fundamentally of iron carbonate ($FeCO_3$). They all weather brown on the outside, and become flaky or even powdery in doing so, passing into earthy limonite. Many shales, such as those of the British Coal-measures, include concretions of iron carbonate, naturally impure by admixture of clay and carbonaceous matter. These are often of great size, standing out in lens-like forms on the sides of cuttings or in river-banks. They are largely used as iron ores. Similar heavy impure concretions occur in the London Clay. In other cases a good deal of calcareous or dolomitic matter is associated with the ironstone, and this is removed in solution on weathering, while the iron carbonate is converted into limonite. Loose and friable residues of the ironstone lumps or pebbles thus remain in some gravels, and go to pieces when pressed between the fingers.

Other ironstones result from the replacement of whole beds of limestone by iron carbonate, the structure of the original rock, with all its fossils, being retained. Such masses are worked as iron ores in the Cleveland district of Yorkshire, where a Jurassic oolitic limestone has been thus altered by infiltering waters. The higher specific gravity and the strong brown staining on the joint-planes suggest the change that has taken place.

Another type of ironstone is that formed by the deposition of limonite (hydrated iron oxide) in beds or cracks of sandstone, the sand-grains becoming cemented by a dark-brown material which stands out on weathering, owing to its resistance to decay. The ironstone bands in the Lower Greensand beds of Kent and Surrey are of this type. Such materials are known in East Anglia as *carstone*, and have been worked for iron.

Bog iron ore is a yellowish or orange form of limonite which accumulates in stagnant waters, where acids from decaying vegetation act on the surrounding rocks. Iron, in various soluble combinations, often as a bicarbonate, is leached out of the adjacent country by peaty streams, and these combinations oxidize in the pools and form insoluble limonite. This type of ironstone may gather in time into hard lumpy beds at the bottom of lakes, pools, and bogs, and the

process is aided by certain freshwater algæ, which actually utilize the iron compounds in their growth and promote an oxidation of the iron. Such iron ore, when discovered where boggy land is drained or cut away, may have a commercial value, being used in the purification of gas from any sulphur that it may contain. See also IRON-PAN. [G. A. J. C.]

Irrigation.—Irrigation and land drainage are complemental arts, brought into requisition when needful in the control of soil moisture for the betterment of conditions in crop production. Irrigation supplements the natural rainfall or spreads water over lands where it seldom rains; underdrainage quickens the country run off or transforms it from excessive, detrimental, erosive surface wash into controlled underflow, discharging into natural or artificial channels. In the broadest and most industrially helpful sense, productive fields in all climates must be irrigated and must be underdrained. Opportune, gentle, and ample rains constitute ideal irrigation. The complete local absorption of rain, and the immediate percolation to below the root zone of the excessive portion of it, constitutes ideal land drainage. But nowhere do such conditions prevail continuously, and hence everywhere conditions arise demanding a conservative and regulative treatment of soils and fields to minimize undesirable evaporation and to direct and control complete absorption and necessary drainage. Irrigation, to supplement rainfall; tillage, to conserve and facilitate its entrance and retention in sufficient amount in the soil; and drainage, for the immediate removal of excessive portions, are three co-ordinate practices whose correct application is fundamentally essential to the highest productive capacity of every field, no matter on what soil. This is so because the right amount of water in a soil, continuously maintained, is indispensable to the highest yields.

AMOUNT OF WATER REQUIRED FOR LARGE YIELDS.—When it is recalled that water contributes more than one-half of the material which makes up the dry substance of crops, and that it constitutes from three-fourths to more than nine-tenths of their green weight, it becomes at once clear that it must be an important factor of yield; but how important is the part it plays is made still more clear by the fact that as an average and under the best conditions of growth there is withdrawn from the soil by the roots of crops and transpired through their leaves or evaporated from the surface of the soil occupied by the crop not less than 450 tons of water for each ton of dry substance produced. The following table gives the mean results of repeated determinations of the amount of water transpired by crops in coming to maturity, including that which is lost through evaporation from the soil upon which the crops grew. In these trials the crops were grown in cylinders 18 in. in diameter and 4 ft. deep, the water being added as needed, usually once per week, the amount applied being determined by weighing each cylinder, water enough being added to bring the cylinders to a standard weight:—

Mean amounts of water transpired by crops in coming to maturity, including evaporation from the soil.

Crop.	Water used.	Produce dried at 102° C.
	inches.	lb. per acre.
Barley	20·69	10,100
Oats	39·53	17,780
Maize	15·76	13,180
Red Clover	22·34	8,780
Field Peas	16·89	8,018
Irish Potatoes	23·76	13,990

It will be seen from these results that the crops used the equivalent of from 15·76 in. of rainfall, in the case of maize, to as high as 39·53 in. in the case of oats, starting with the soil in good moisture conditions, and closing the season of growth with the same amount of water present. The produce of water-free substance was relatively large per unit area in each case when compared with good field yields, and to this fact is due in part the large consumption of water measured in inches upon the surface occupied by the crop; but that the amounts of water necessary for heavy yields of these crops are really large will be made clear by the next table:—

Amounts of water transpired by crops in coming to maturity, including evaporation from the soil, per one ton of produce.

Crop.	Tons of water per ton of green product, 80 per cent of water.	Tons of water per ton of dry product.	Tons of water per ton of protein, carbohydrate, and ether extract.	Acre-inches of water per ton of dry product.
Barley	92·8	464·1	651·7	4·10
Oats	100·8	503·9	761·7	4·45
Maize	54·2	270·9	415·6	2·39
Red Clover	115·3	576·6	933·6	5·09
Field Peas	95·4	477·2	848·4	4·21
Irish Potatoes	77·0	385·1	453·0	3·40

This table shows that for each ton of dry substance produced by the oat crop more than 500 tons of water are lost from the soil by transpiration through the crop and evaporation from the soil upon which the crop grows, and that this is equivalent to 4·45 in. of rainfall; and that in proportion to the produce of protein, carbohydrates, and ether extract the legumes named use the largest amount of water, while maize and potatoes use the smallest.

Stating the consumption of water by crops in the ordinary terms of expressing yield, the amounts stand as given in the next table:—

Highest probable duty of water for different yields per acre for different crops.

Yield per acre in Bushels.	Least number of Acre-Inches of water.				
	Wheat.	Barley.	Oats.	Maize.	Potatoes.
15	4·5	3·21	2·35	2·52	—
20	6·0	4·28	3·13	3·36	—
30	9·0	6·42	4·70	5·04	·82
40	12·0	8·56	6·27	6·72	1·10
50	15·0	10·70	7·84	8·40	1·37
60	18·0	12·84	9·40	10·08	1·65
70	—	14·98	10·98	11·75	1·92
80	—	—	12·54	13·43	2·20
100	—	—	15·68	16·77	2·75
200	—	—	—	—	5·49
300	—	—	—	—	8·24
400	—	—	—	—	10·99
Tons per acre:—	1	2	3	4	6
Clover hay * ...	4·48	8·85	13·38	17·70	26·55
Tons per acre:—	10	12	14	16	18
Maize with ears †	20·72	24·95	29·10	33·26	37·42
Maize silage ...	7·17	8·61	10·04	11·48	12·91

* 15 per cent water. † 70 per cent water.

It should be understood that in each of these three tables the values computed for the duty of water are high because, while based upon actual observed relations of yield to amounts of water used, the conditions under which the experiments were made were all both extremely favourable for growth and for the minimum loss of water by either percolation or by evaporation from the soil surface itself. Moreover, the water was always applied to the soil with sufficient frequency and regularity, so that growth was never checked by either a deficiency or an excess of water in the soil. So, too, there was always present in the soils used an abundance of available plant food other than water, which tended to make the yield, in proportion to the water used, near the maximum, and thus to give a duty of water which can be realized in field practice only under the most favourable conditions and with the best management of both soils and crops.

But even under these conditions of greatest economy of water it is important to recognize that the amount required for heavy yields is very large even when compared with the effective rainfall of the growing season of most temperate humid climates. The general truth of this statement is made clear by the table of rainfall for Madison, Wisconsin, during twenty-six years, covering the season of active growth, from early April to late September inclusive. (See top of page 172). In this table three crops, hay, maize, and potatoes, are considered, and the amounts of rainfall during the actual period of growth of each crop are given, classified under years when the decisive rainfall of the season was ample, had it been properly distributed, for 2 tons of hay, 400 bus. of potatoes, and between 50 and 55 bus. of maize per acre, and years when the amounts were insufficient to permit such yields on well-managed fertile soils in good condition.

The data of this table show that during nineteen out of twenty-six years the rainfall has been less than that indicated as needful for the production of 2 tons of clover hay per acre, as shown in the above table, which is 8·85 in., where the amount needed was the result of having applied water only in the amounts required, and always with that frequency which permits no check to growth due to a deficiency in the amount of soil moisture. During the six years of the period under consideration, 1896 to 1901, supplemental irrigation was applied to one or both crops of hay with marked effect in increasing the yield on a medium clay loam soil of the Wisconsin Experiment Station farm. The results secured are indicated in the next table.

Mean yields of clover, oat, or alfalfa hay, computed to 15 per cent moisture, under supplemental irrigation, at the Experiment Station farm, Madison, Wis.

Year.	Rainfall for two crops.	Irrigation for two crops.	Total water for two crops.	Yield per acre.
	in.	in.	in.	lb.
1896	14·06	6·97	21·03	8088
1897	9·44	5·84	15·28	8868
1898	16·74	6·00	22·74	8062
1899	14·39	3·88	18·27	8484
1900	16·86	6·00	22·86	9162
1901	7·28	10·00	17·28	9816
Average	13·13	6·45	19·58	8746

The data of this table show that supplementing the rainfall, ranging from 7·28 to 16·86 in., falling between April 10 and August 19, has permitted the production of more than 8000 lb. of hay, containing 15 per cent of moisture, from

Rainfall of periods of active growth for clover, maize, and potatoes at Madison, Wisconsin, during twenty-six years, compared with the amount of water required for 2 tons of hay, 55 bus. of maize, and 400 bus. of potatoes per acre.

Year.	Rainfall not sufficient.				Rainfall sufficient if well distributed.			
	1st crop Hay, Apr. 10–June 19.	2nd crop Hay, June 20–Aug. 18.	Potatoes, June 20–Sept. 17.	Maize, June 20–Aug. 18.	1st crop Hay, Apr. 10–June 19.	2nd crop Hay, June 20–Aug. 18.	Potatoes, June 20–Sept. 17	Maize, June 20–Aug. 18.
1882	7·33	—	—	—	—	13·35	16·34	13·35
1883	—	—	—	—	17·34	10·11	13·55	10·11
1884	—	—	—	—	10·21	12·46	18·06	12·46
1885	8·21	—	—	—	—	11·74	18·02	11·74
1886	5·33	4·82	7·38	4·82	—	—	—	—
1887	3·37	—	—	—	—	9·02	13·76	9·02
1888	6·94	4·90	5·93	4·90	—	—	—	—
1889	6·36	2·89	4·71	2·89	—	—	—	—
1890	—	6·36	9·37	6·36	12·00	—	—	—
1891	4·47	4·47	5·79	4·47	—	—	—	—
1892	—	4·87	10·98	4·87	14·49	—	—	—
1893	—	7·07	7·07	7·07	11·48	—	—	—
1894	8·05	5·36	9·28	5·36	—	—	—	—
1895	2·07	1·38	3·35	1·38	—	—	—	—
1896	8·61	5·91	9·34	5·91	—	—	—	—
1897	5·05	5·25	7·92	5·25	—	—	—	—
1898	8·57	7·96	7·97	7·96	—	—	—	—
1899	—	6·24	8·01	6·24	9·57	—	—	—
1900	5·06	—	11·80	—	—	9·33	—	9·33
1901	4·57	2·74	6·69	2·74	—	—	—	—
1902	8·71	—	—	—	—	11·28	12·62	11·28
1903	7·18	—	—	—	—	12·06	17·00	12·06
1904	6·78	5·81	11·56	5·81	—	—	—	—
1905	—	4·38	6·08	4·38	9·40	—	—	—
1906	5·66	—	—	—	—	10·50	12·30	10·50
1907	5·98	8·56	—	—	—	—	13·50	8·56
Average inches	6·25	5·23	7·83	5·03	12·07	11·09	15·02	10·84
Number of years	19	17	17	16	7	9	9	10

an acre of moderately fertile clay loam soil in two cuttings and without the application of commercial fertilizers, but treated with stable manure at the rate of 16 to 20 tons per acre once in four years, corn and potatoes being grown in rotation with the clover, the clover being seeded with either barley or oats.

In three other years of heavier rainfall the same plots gave, in two cuttings, the following yields:—

Yields of hay without supplemental irrigation.

Year.	Rainfall, two crops.	Yield per acre.
	in.	lb.
1905	13·63	4028
1906	17·05	4642
1907	14·92	5920
Average	15·30	5300

From these results it appears that the rainfall during the decisive period of growth for hay in no one of these nine years has been such in amount, distribution, and character but that supplemental irrigation did or would have increased the yield from a mean of 5300 lb. per acre, under a rainfall of 15 in., to one of 8746 lb., or an increase of 3446 lb., which is 65 per cent and more than 1·5 ton per acre, when the water for the two crops was increased by supplemental irrigation to 19·58 in. It should be stated further in this connection that with supplemental irrigation it was possible to take three cuttings of clover and four of alfalfa, while without it it was not always possible to take more than one paying crop, and never more than two of clover.

When supplemental irrigation was practised upon maize and upon potatoes in rotation with the clover on the same soils and plots, but where portions of each plot each season received no supplemental irrigation, there was a mean gain in yield during the years 1894 to 1901 of 41·3 per cent over the yield of maize not irrigated, and in the case of the potatoes a gain of 79·16 per cent, the mean yields of marketable tubers having been 361·17 bus. on the areas where supplemental irrigation was practised, and 201·5 bus. per acre where the crop grew under natural rainfall conditions.

The mean rainfall in England, at Rothamsted, during the twenty-three years ending 1901, for April to September inclusive, has been 14·76 in., and for April 10 to August 20, the period when deficiencies in rainfall most influence yield, has been only about 11·75 in. This amount is 7·73 in. less than that which produced a mean yield of hay in two crops of 8746 lb. per acre under supplemental irrigation, and it is 3·55 in. less than under natural rain-

fall conditions gave a mean yield in two crops of 5300 lb. of hay. It is clear, therefore, that when all other factors of growth are favourable, rainfalls of small amount or of unfavourable distribution must invariably become limiting factors of growth in many if not in most parts of England, and in other countries having similar climate, as well as in the United States.

FACTORS WHICH MODIFY THE EFFICIENCY OF RAINFALL.—When intensive plant husbandry becomes general, and each crop represents a high acre value, it will be found desirable in most humid climates to practise supplemental irrigation, for, when this is done, yields will not only be generally higher, but greater uniformity in both amount and quality of product from year to year will be ensured. There are many factors which modify the efficiency of natural rainfall, tending to make its influence on plant growth less than it would otherwise be, could it be under absolute control, both in time and amount, as is largely the case with water applied in irrigation.

The truth of this statement becomes clear when it is said that the transpiration from a growing crop is far from being uniform from week to week throughout its period of growth, as is illustrated in fig. 1, showing variations in the amount of transpiration by periods of 10 days, from the time of planting to the date of maturity, in the case of maize, where the yield per acre exceeded 5 tons of dry substance. Immediately following planting, because the soil surface was wet and became gradually drier, there was at first a diminished loss of water; but, following this, there was first a gradual and then a very rapid increase in the rate of loss of water from the soil until near the middle of the period of growth, when the consumption of water was strong. During the first 30 days after planting, the withdrawal of the water from the soil was at a mean rate of ·29 in. for each 10 days, and this represents chiefly the loss of water by evaporation from the soil itself. During the next 10 days the loss had increased to nearly ·9 in. for the period, and in the 10 days following the consumption increased to 2·19 in. There are 40 days when this crop withdrew from the soil more than 2 in. of water for each 10 days, which is a consumption exceeding the mean Rothamsted rainfall for the corresponding season more than twofold. In the case of an oat crop in which the total dry weight was at the rate of 9099 lb. of dry substance and 98 bus. of grain per acre, the loss of water from the soil during the first 5 weeks was at a mean rate of ·464 in. per week; during the next 2 weeks the loss was at the rate of 1·58 in. for each week; while the following weeks showed a loss from the soil of 2·51, 3·15, 3·54, 3·45, 3·28, 3·20, 2·83, 4·06, and 3·42 in. respectively, the oats having been cut with the straw still green. Thus, it is seen, such an oat crop during the last 8 weeks of growth may withdraw from the soil more than 3½ in. of water every 7 days, and this exceeds the Rothamsted mean monthly rainfall for the corresponding period, and is more than three times the amount of water used by the crop during the first 8 weeks of its growth. Moreover, the Rothamsted rainfall during the first 8 weeks of active growth for oats must very often be in excess of the crop demand, and, except when there has been a previous deficiency of soil moisture, may prove harmful.

Another factor which diminishes the efficiency of rainfall in humid climates, as compared with that in those which are semi-arid, is the relatively larger evaporation from the soil, due to the surface soil being much of the time wet from frequent rains. This effect is seen in fig. 1, where the evaporation decreases during about 20 days on account of the increasing efficiency of the earth mulch as it becomes more dry. Naked soil surfaces have been observed to lose water during the growing season and

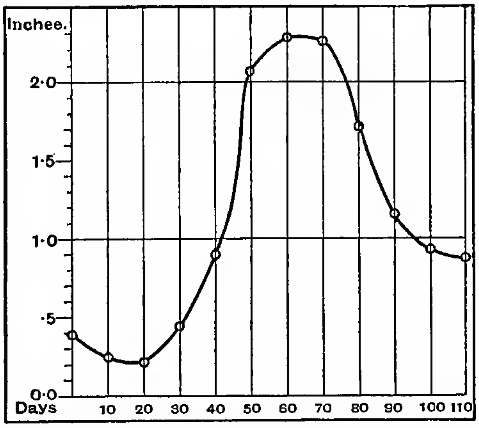


Fig. 1.—Loss of water from soil during periods of ten days, by evaporation and by transpiration from maize growing upon it. Mean of twenty trials, when the yield was at the rate of 11,156 lb. of dry substance per acre, or 15,937 lb. containing 30 per cent of water.

under field conditions at the rate of 2·12, 1·92, 1·53, and 1·80 in. of water per 10 days at Goldsboro, North Carolina; Upper Marlboro, Maryland; Lancaster, Pennsylvania; and at Janesville, Wisconsin, respectively, making an average 10-day loss of 1·84 in.

In arid regions where irrigation is practised, and in semi-arid regions where 'dry farming' is practised, the loss of moisture through evaporation from the soil itself is materially less than it is in humid climates, where the surface is repeatedly wet by rains, and for this reason the efficiency of rainfall and the duty of water applied in irrigation are higher than in humid climates. But in humid climates the loss from surface evaporation is not nearly so high as is that observed to take place from continuously wet soil, as stated above, for the reason that on well-drained soils the immediate surface quickly dries, and with this the rate of evaporation falls. The naked soils of the Rothamsted drain gauges, for example, show a mean evaporation during the months of April to September of 4·78 in. per 100 days, or less than ½ in. per 10 days, and our own observations show a similar order of value, thus:—

Loss of water by surface evaporation from soil under different conditions.

Depth of earth mulch ...	0 in.	1 in.	2 in.	3 in.	4 in.
	Soil saturated 19 in. below surface.				
	Inches evaporation per 100 days.				
Humus soil ...	5·48	3·24	2·42	2·20	1·89
Sandy loam ...	6·39	3·51	2·55	2·38	2·22
Clay loam ...	15·71	11·01	9·08	8·60	7·78
	Soil saturated 120 in. below surface.				
	Inches evaporation per 100 days.				
Sandy loam ...	2·30	—	—	1·14	—
Clay loam ...	2·99	—	—	2·13	—

In this table the sandy loam and the clay loam in the two sections are the same soils, and in all cases the evaporation is what has resulted when the surface is continuously without rain, as might be the case under strictly arid conditions. The table makes it clear that the loss of water by evaporation varies in a marked degree with the character of the soil, with the treatment of the surface, and with the depth below the surface at which the soil is continuously saturated. It is also very clear from these figures that dry earth mulches, whether compact or loose, greatly retard the loss of water by evaporation from the surface of fields.

In view of the facts here stated and of the additional ones, namely, that the shading of the soil surface and the shielding of it from wind movement by the crop growing upon the ground decrease the direct evaporation from the soil itself, it becomes evident that, after all, the major loss of rain falling on the field or applied in irrigation must be through the foliage of the crop itself, so long as it does not escape as drainage; and hence that if large yields are to be expected these can only be ensured by water made available in the soil to the crop as it is needed, and in proportion to the yield which is expected.

Again, the efficiency of rainfall and of water in irrigation is very greatly modified by the productive capacity of the soil as influenced by other factors than the right amount of moisture. A soil highly fertile and in good condition permits the same amount of moisture to produce heavier yields than is possible with like amounts of water when applied to less fertile soils. To illustrate: the first crop of maize grown on the virgin clay loam in our twenty large cylinders gave a yield of 22,313 lb. of dry substance per acre, using water at the rate of 31·57 in. per 100 days, and 313·6 lb. of water per pound of dry matter, while the eighth consecutive crop without fertilization gave a yield of 6322 lb. per acre, using water at the rate of 16·38 in. in 100 days, but at the rate of 592·8 lb. for each pound of dry substance produced. So in the case of oats the second crop on the virgin soil gave a yield of 18,664 lb. of dry substance per acre, using 31·44 in. of rainfall per 100 days, and at the rate of 450·4 lb. of water per pound of dry substance; while the tenth crop produced 9196 lb. of dry substance per acre, using 23·51 in. of water in 100 days and 800 lb. for each pound of dry matter, the crop being matured in 115 days and the other in 118 days. The second crop on the ground gave a yield at the rate of 201 bus. of grain per acre, while the tenth crop was at a computed rate of 99 bus. per acre. It may be said in explanation of such large yields that the entire depth of soil in the cylinders was composed of the surface 6 in. of virgin soil, and that in regions of fertile deep soil where irrigation is practised, yields of oats on large fields often average above 100 bus. per acre.

With potatoes on the same soil and under like conditions the first crop produced a yield of 17,334 lb. of dry substance per acre, using water at the rate of 300·6 lb. for each pound of dry substance; the second crop required 320·5 lb. of water per pound of dry substance, with 12,193 lb. per acre; while the ninth consecutive crop, with a yield of 12,967 lb. per acre, required 576 lb. of water per pound of dry substance to produce it. Again, with the second crop of potatoes, maturing in 116 days, and the seventh crop, maturing in 117 days, producing yields of 12,193 and 12,607 lb. of dry substance per acre respectively, the former used only 17·38 in. of water, while the latter used 35·34 in., more than twice the amount in practically the same time. It appears that after the seventh crop had been put upon the soil conditions had changed, which were unfavourable to the storing of starch in the form of tubers, and the result was that while practically the same amounts of dry substance were produced in the two cases, starch was stored at the rate of 815 bus. of potatoes per acre in the one case, and 285 bus. in the other, the dry matter produced in the form of excessive stem and leaf growth, causing the excessive use of water. From these relations of yield to water lost from the soil in producing the crop, it appears that efficiency is highest when the soil contains an abundance of available plant food in all its essential forms other than that of water.

If, however, there is present in the soil an abundance of plant food, but the water is insufficient for maximum yields, then the crop is cut down nearly or quite, in proportion to the deficiency of water. Thus, it was found with maize, oats, and potatoes growing side by side in the same kind of soil, that where water was applied every week to restore that which had been lost, while in other cases it was applied at longer intervals and not in sufficient amount to restore that lost, larger yields were secured where the larger amounts of water were applied, and nearly in proportion to the amounts of water used, as indicated in the next table.

Relation of yields to water used when soil is abundantly fertile and where water is ample or not sufficient.

Crop.	Water used.	Yield per acre.	Water per pound, dry substance.
	in.	lb.	lb.
Maize ...	17·32	16,424	274·75
Maize ...	10·49	11,121	245·82
Potatoes ...	14·98	12,193	320·55
Potatoes ...	8·51	7,287	304·35
Oats	31·44	18,664	450·39
Oats	14·53	8,674	449·04

In these cases the water used by the corn stands in the ratio of 1 to 1·65, while the yields stand in the ratio of 1 to 1·48. With the oats the water stands in the ratio of 1 to 2·16, while the yields are in the ratio of 1 to 2·15; while with the potatoes the ratio of yield is 1 to 1·76, and that of water used 1 to 1·67, showing that they are nearly proportional to the amounts used by the three crops.

From the table above it might be inferred that water is used with greater economy, so far as water per pound of dry substance is concerned, when less is applied, and hence that in arid climates, where there is more land than water for irrigation, the aim should be to bring under irrigation the largest practicable acreage. There is no doubt that where the interval between waterings is made longer there is less lost by evaporation from the soil, and hence a larger proportion of the water applied is left to pass through the crop if no seepage below root action has taken place; but it is also quite certain that in each of the cases cited the slightly higher efficiency of water indicated in the table is apparent rather than real; because, even in the case of the corn, where the difference in efficiency appears highest, a greater soil evaporation of only ·5 in. during the 115 days of growth, on the surface watered every week, would make the efficiency of transpired water identical, and yet there can be no doubt that the evaporation from the most frequently watered soil exceeded that from the other by more than ·5 inch, and hence it must be concluded that in point of fact the transpired moisture in these trials had a higher efficiency where most water had been applied.

The efficiency of a given rainfall cannot be the same on all soils, not only because the loss by evaporation varies, but also because the loss by percolation may be different with soils of different texture. In the case of a coarse sandy soil, on which a rainfall for the growing season of 10·72 in. gave a yield of 96 bus. of potatoes per acre, and upon which 15·7 in. additional water, applied as supplemental irrigation, increased the yield to 153 bus., it was found that maize wilted during the middle of the day when the water content of the surface 4 ft. of soil aggregated 2·99 in., with 1·15 in. in the surface foot. It was also found that when the water content of the surface 4 ft. reached 5·73 in. and the surface foot 2·57 in., percolation below the depth of 4 ft. would take place. The difference between the maximum amount of water retained by capillarity and that present in this soil when the crop wilted is 2·74 in. It is clear, therefore, that so long as the rainfall holds the water content in such a soil materially above 2·99 in., and which is required for best growth, amounts of rainfall between 1·5 and 2 in. are quite certain to result in loss by percolation below the depth of root action. The records of the Rothamsted drain gauges show that for that section of England a crop using 10·63 in. of water would permit in that soil 3·95 in., on the average, of the April-to-September rainfall to percolate beyond the 5-ft. depth. According to the table on page 171, 10·63 in. of rain should permit a yield, were it timely and did it fall in a way to be most efficient, of 35 bus. of wheat, 50 bus. of barley, 385 bus. of potatoes, and 4800 lb. of hay in two crops, per acre. These wheat, barley, and potato yields are large, but quite within the possibilities for the best soils in prime condition when the rainfall is best both in amount and distribution. It is true, however, that the period from April 1 to September 30 is longer than that of decisive rainfall for either of these crops. Taking the decisive rainfall periods, as given in the table on page 172, these four crops, assuming a proportional rainfall and drainage, would be reduced

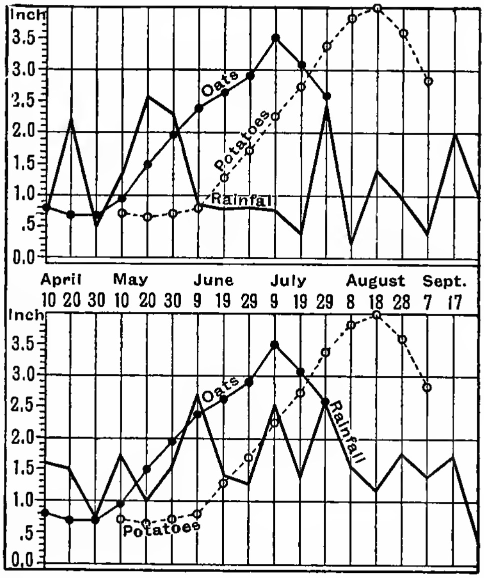


Fig. 2.—Relation of rainfall to amount of water required for a crop of 125 bus. of oats and 713 bus. of potatoes per acre. The rainfall during successive ten days and the water used by the crops are plotted in inches. The upper section represents the rainfall of the wettest season in twenty-six years, and the lower one the mean rainfall of the six wettest seasons in twenty-six years at Madison, Wisconsin.

by the available amount of water so as to leave the yields, instead of those given above, 17 bus. of wheat, 24 bus. of barley, 217 bus. of potatoes, and 3548 lb. of hay per acre, which are less than those usually obtained on such soils in good condition; but it is also true that the loss of water from cultivated fields under crop on such soils is probably less than that shown by the Rothamsted drain gauges, which have been maintained in naked, fallow condition, for, with less loss of water by drainage, more would be available to the crop and proportionately larger yields would be possible.

It appears clear from these considerations that even when such soils are maintained at a high stage of productive capacity, available soil moisture in most humid and in all semi-humid climates becomes the limiting factor of yield, and hence that, on the average, supplemental irrigation is certain to make higher gross returns possible, and, judging from the results

obtained at the Wisconsin Experiment Station, net returns should be materially increased.

It is the distribution and character of the rainfall of the growing season more than its amount which determines yields in those cases where soil moisture is the limiting factor of growth. It is doubtful if any soil in good physical condition for culture crops can retain sufficient moisture to maintain the strongest growth

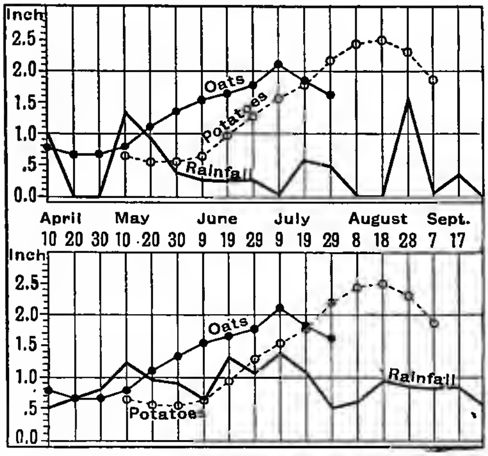


Fig. 3.—Relation of rainfall to amount of water required for crop of 62·5 bus. of oats and 400 bus. of potatoes per acre. The rainfall during successive ten days and the water used by the crop are plotted in inches. The upper section represents the rainfall of the driest season in twenty-six years, and the lower one the mean rainfall of the sixteen driest seasons in twenty-six years at Madison, Wisconsin.

during more than ten consecutive days of the season of highest consumption of water, so that when longer intervals occur without effective rains, growth must be checked and yields necessarily reduced. The writer does not have access to daily rainfall records of England, but, in illustration of the principle, at Madison, Wisconsin, where the mean June, July, and August rainfall averages 10 to 12 in., and exceeds that at Rothamsted by 2 to 4 in., the distribution by 10-day periods is rarely such as to render maximum yields possible, as may be seen from an inspection of figs. 2 and 3, where the rainfall of April 1 to September 27 is plotted in 10-day sums, together with the amounts of water lost from the soil under crops of oats and potatoes, from the time of planting to that of maturity. The upper section of fig. 2 shows the relation of the rainfall of the wettest season in twenty-six years to the amounts of water demanded for a 125-bus. crop of oats and a 713-bus. crop of potatoes per acre, while the lower section shows the water used by the same crops compared with the mean rainfall of the six wettest seasons in the same period of years. In fig. 3 similar comparisons are made between the water used by half yields of the same crops and the rainfall of the driest season, and with the mean rainfall of the sixteen driest seasons. It appears from fig. 2, for both oats and potatoes, in the wettest season, that not only was the rainfall inadequate for such large yields, but that the smallest rainfall occurred at the period when the demand for water was largest. Even such season rainfalls as that indicated by the mean of the six wettest seasons could not sustain such large yields, and indeed only those of about half these values. In fig. 3 it is made clear that the rainfall of the driest season falls far short of supplying the water demanded by 62·5 bus. of oats and by 400 bus. of potatoes per acre, and also that such rainfall as is represented by the mean for the sixteen driest seasons cannot produce such yields.

In 1897, when the rainfall was distributed as represented in fig. 4, and produced a yield of 250 bus. of potatoes per acre, requiring the computed amount of water indicated by the curve with the open circles, supplemental irrigation applied to alternate groups of six rows in the same field and under otherwise identical conditions increased the yield to 375 bus. per acre. The shaded area in the figure shows when and the extent to which water was added, and the curve of solid circles shows how the computed amount of water needed for such a crop compares with the actual water used. The natural rainfall of the period when the crop was needing most water, as shown in fig. 4, was markedly less than the amount required for the 250 bus. per acre, and it was the withdrawal of the stored water from the soil, and the consequent rendering of it drier, that limited the yield to the 250 bus. Determinations of soil moisture were not made at this time, but it is probable that the reduced water content of the soil of the root zone, on the area not irrigated, added to the rainfall, would equal the deficiency shown between the computed curve for 250 bus. of potatoes and the recorded rainfall.

Such large yields as 125 bus. of oats and 713

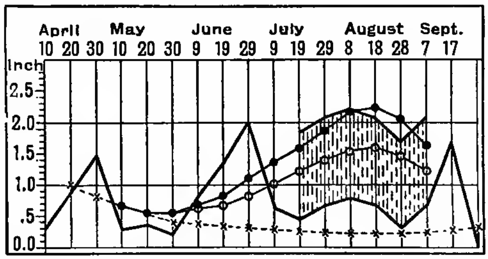


Fig. 4.—Showing the distribution and amount of rainfall when supplemental irrigation increased the yield of potatoes from 250 bus. to 375 bus. per acre. The solid heavy line represents the season rainfall; line of solid dots, the water demanded by 375 bus. of potatoes; and the one with open circles, the water used by 250 bus. The broken line is the approximate loss of water by evaporation from the soil. The shaded area represents the water added by irrigation.

bus. of potatoes, considered in fig. 2, are by no means impossible for field conditions where the soil is deep, well-drained, and highly fertile, and are realized in the best irrigation practice. The truths and underlying principles, therefore, which are given visual expression in figs. 2, 3, and 4, have the highest significance in the possibilities they reveal, which are open to the agriculture of the future when it shall become necessary to fully utilize the water resources of countries with humid climates, as is coming to

be the practice in countries with arid climates. They also give expression in a forceful way, not only to the amount of water that is required in irrigation, but emphasize the important fact that the amount supplied to a given crop should vary at different stages of its maturity.

AMOUNT OF WATER USED IN IRRIGATION.—The duty of water in irrigation has reference to the amount of land served by a given volume of water. In Italy, where irrigation has long been systematically practised, a flow of 1 cu. ft. of water per second serves for ordinary crops about 70 ac., and this is equivalent to 3·4 in. of rainfall per 10 days; while for rice irrigation the water allowed is equivalent to 5·55 in. per 10 days. In Spain, with a drier climate but greater economy in the application of water, one second-foot is made to serve about 100 ac., equivalent to a rainfall of 3·35 in. per 10 days. On the upper Garonne in France, contracts call for water at the rate of 2·55 in. per 10 days, but in Vaucluse concessions as low as 1·36 in. are allowed. In Egypt, winter irrigation is applied at the rate of 3·94 in. in 40 days, which is but ·98 in. per 10 days; during the summer, however, cotton is given water at the rate of 1·7 in., rice 3·41 in., and maize 2·27 in. per 10 days. E. Perels gives the duty of water in Algeria as follows:—

Water required for irrigation in Algeria.

Crops.	No. of Waterings.	Water used.		Length of Culture Period.
		Each Application.	During the Season.	
		inches.	inches.	days.
Alfalfa	10	1·575	15·75	180
Vegetables	36	1·575	56·7	180
Cotton, flax, and sesame ...	10	2·52	25·2	150
Maize	4	1·575	6·3	60
Winter grain	3	3·937	11·87	210
Oranges	12	1·575	18·9	180
Tobacco	4	1·575	6·3	90
Grapes	4	4·725	18·9	90

The highest duty of water of which we have any record is from Southern California, where extreme economy is practised, and here one second-foot serves 500 ac., which is less than ½ in. of water per 10 days.

Mead found the following values for the duty of water in the United States, from measurements made in 1904:—

Water used for different crops.

Crop.	Depth of Irrigation.	Irrigation Season.	Amount per 10 days.
	inches.	days.	inches.
Potatoes ...	47·28	121	3·90
Alfalfa ...	40·68	175	2·32
Orchard ...	33·12	190	2·37
Wheat ...	32·16	117	2·66
Oats	20·76	90	2·30
Barley ...	16·68	49	3·65

Eckart, under Hawaiian conditions, found by critical measurements of water used and crop produced on experimental plots, the following amounts for sugar cane.

Average for Lahaina and Rose Bamboo (Hawaii).

Irrigation.	Total Water.	Water per 10 days.	Total Solids.	Water per lb. of Solids.	Sugar per acre.
	inches.	inches.	lb.	lb.	lb.
1 in. each week	131·51	1·88	88,189	333	21,911
2 in. each week	188·51	2·70	88,125	486	22,889
3 in. each week	245·51	3·51	93,107	592	23,992
2 in. each two weeks ...	134·51	1·92	88,566	342	22,258
3 in. each three weeks ...	137·51	1·97	80,320	388	19,184

It will be seen from this table that the amount of water used per pound of dry product has the same order of value as that for ordinary crops, so that the large amount of water used and the very heavy yields per acre are due to the long period required to mature the crop of cane.

Using one hundred cases at hand from all parts of the world, but excluding those applying to rice culture and the irrigation of water meadows, it appears that, as a general average, 1 cu. ft. of water per second is made to serve 117·6 ac., which, expressed in rainfall per 10 days, represents a depth of 2·024 in., and 20·24 in. for an interval of 100 days.

FREQUENCY OF IRRIGATION AND AMOUNT TO BE APPLIED AT ONE TIME.—The fundamental conditions which determine the amounts of water which should be applied at one time are: (1) The capacity of the soil and subsoil to store capillary water; (2) the depth of the soil stratum penetrated by the roots of the particular crop; (3) the rate at which soil below the root zone may return water into it by capillarity; and (4) the extent to which the soil of the root zone has become dried out.

Water required for crop growth is here alone under consideration. The amount of water required for each irrigation, where the soil has not been permitted to become too dry for good growth, and where the object is to bring the moisture to the upper limit of productive efficiency without causing percolation below 4 to 5 ft., will range between 2·5 in. for soils of coarse grain and open texture, to 4·5 in. for those of average loamy texture. If excessive drying of the soil has taken place, the amount of water which may be applied will range from 3·75 in. for open coarse soils, to even 11 in. on those of medium and fine texture.

On the other hand, the conditions which determine the frequency of irrigation are: (1) The amount of available moisture which may be stored in the root zone; (2) the rate at which this moisture is lost through the crop and soil surface; and (3) the degree of desiccation of the soil which the particular crop will tolerate before serious interference with growth results.

Viewed from the standpoint of labour in distributing water in irrigation the fewer the number of applications the better, and the less will be the loss of water by surface evaporation and by seepage through canals and laterals in bringing water to the field. The general practice should be to apply as much water to the field each time as the crop will tolerate in the root zone, and then to husband this water in the most thorough manner practicable.

As a 70-bus.-per-acre crop of maize may be brought to maturity in 110 days with a consumption of 11·75 in. of water, and as the root zone may carry from 2·5 to 4·5 ac.-inches of available moisture, the best management should be able to mature the crop with five irrigations on the most open, and with three on the medium soils, making the intervals between irrigations 22 to 37 days. But if the yield sought is 100 bus. per acre, then the watering, during the interval of greatest water consumption, must be more frequent, following in 15 to 27 days, or shorter intervals where higher yields are expected. On a similar basis of calculation and with the highest duty of water, a 40-bus. crop of wheat would require three to five irrigations at intervals of 33 to 20 days, and a 60-bus. crop of barley would call for the same number of irrigations at intervals of 29 to 18 days, according as the soil texture is close or open.

In southern Europe wheat is irrigated three to four times, in India five times during the hot season and four times during the cool season. The average number of irrigations for wheat in all parts of the world ranges from three to five, but it should be understood that in all these cases the irrigation is merely supplementary to a greater or less rainfall, and further, that the average yields are materially below 40 bus. per acre.

In Egypt maize is irrigated seven times, in New Mexico six times, while in Italy three is the usual number, but here again the spring and summer rainfall is quite large. For alfalfa and for clover the usual practice is to give one irrigation for each cutting, but our experience leads to the conviction that two irrigations would ensure larger yields.

With potatoes the general practice is to plant with the soil in prime moisture condition, and then if possible wait until the plants fairly cover the ground and the tubers begin to set, and then to irrigate two to four times, varying with soil and season. In potato irrigation it is very important not to permit the soil to become too dry between irrigations after the tubers have begun to develop, otherwise the tubers will begin to ripen, and succeeding waterings will tend to cause new tubers to set either on the stems or on the tubers already formed, and thus diminish the marketable yield.

Fruit trees in Sicily and in southern Italy are watered every 7 to 14 days during the growing season. In Algeria and in Spain oranges are irrigated the year round every 15 days in the spring and summer, but at longer intervals the balance of the year. Grapes, if irrigated, are usually watered every 10 to 20 days, the younger vineyards more frequently than those more mature.

Rice in Italy is kept flooded from the time of seeding until the season of bloom, when the water is drawn off and subsequent irrigation practised every few days. In Egypt the water in the rice basins is changed once in 15 days, and in India this crop gets twelve irrigations.

Conditions which modify the Duty of Water in Irrigation.—Much of what has been said regarding conditions which determine the efficiency of rainfall applies with some modifications to the duty of water in irrigation. The highest duty of water for a given crop and soil is attained when the maximum per cent of the water applied is lost by transpiration through the crop, and the minimum per cent by percolation below the root zone or by evaporation from the surface soil. It is of course not practicable to attain an efficiency of 100 per cent under any management.

The seepage and evaporation from canals and laterals is necessarily very large unless their bottoms and sides are cement-lined. Observations show that as a general average little more than half the water taken out of streams at the head gates of canals becomes available on the fields. The average loss for many canals in India amounts to 47 per cent. The Pioneer canal in Wyoming, carrying 8·01 acre-feet per acre, delivers to the laterals but 1·41 acre-foot, while the canal of the Turlock district, California, standing at the other extreme, delivers to the laterals 7·69 acre-feet per acre out of a total of 8·34 acre-feet taken in at the head gate. Four other canals, with the two just named, carrying an average of 7·86 acre-feet of water per acre, are able to deliver a mean of but 3·7 acre-feet to the laterals.

In the distribution of water after it has reached the field the highest duty is made possible only where the surface has been properly graded so that the water may be led readily over the field, wetting the whole uniformly, fully, and only to the depth of the root zone. If more water than enough to saturate the root zone is applied at one time the harm done is not limited to the waste of water, for this excess carries with it much of the most soluble and most readily and

immediately available plant food The intelligent application of water demands on the part of the irrigator a knowledge both of the amount required for a given field, and of the time needful for the proper distribution of the water throughout the soil. In furrow irrigation it must be remembered that the direct downward flow into the soil beneath the furrows is many times more rapid than the lateral spread due to capillarity, so that much skill and good judgment are required in placing the furrows at the best distance apart and in gauging the water allotted to each furrow, permitting the whole to be taken care of by the lateral action of capillarity before the water reaches a depth below the root zone. The great danger lies in applying too much water, so that some portions of a field become oversaturated before a sufficient amount has reached others.

In furrow irrigation the aim should be to have the furrows neither too long nor too far apart, so that the water may be gotten, without washing, the full length of the furrow quickly, and then to cut down the supply until it is just sufficient to reach the lower end, thus permitting the water to be drawn off into the soil between the furrows by capillarity. Deep furrows permit this to be done more effectually than shallow ones, for in them the distribution of water results in less surface evaporation; but such furrows may result in injurious root pruning in some cases.

It must be remembered, in applying water by whatever method, that the evaporation from wet soil is much more rapid than it is from dry.

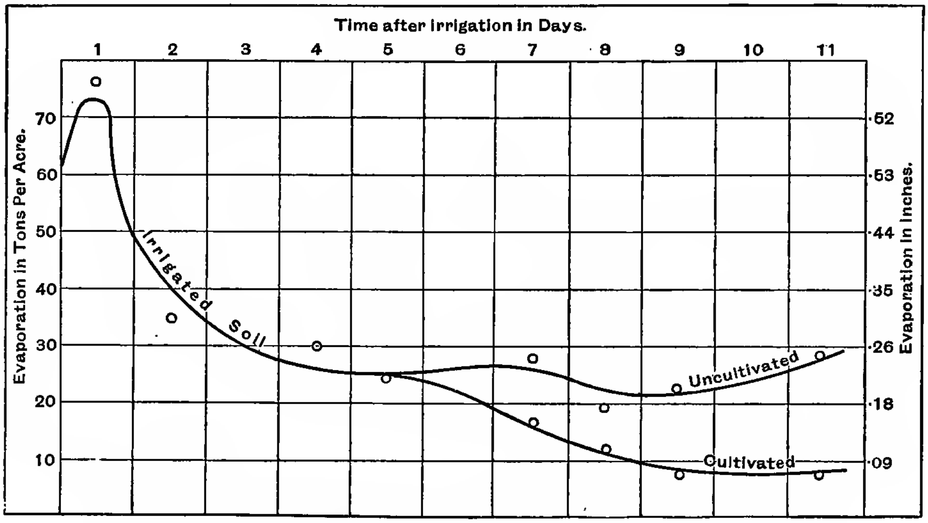


Fig. 5.—Diagram showing saving of water resulting from earth mulch formed by cultivation.

Indeed, under like conditions, the loss by surface evaporation decreases from a maximum at saturation with a rate nearly directly in proportion as the water content of the surface layers diminishes. It has been stated (p. 173) that in humid climates the rate of evaporation from continuously naked wet soil may reach a mean season value of 18·4 in. per 100 days, while continuously dry soil may permit a loss no greater than 1·3 to 2·99 in. in the same time. Cultivation as soon as possible after irrigation, to develop a dry, loose earth mulch, is one of the most effective ways of increasing the duty of water, as illustrated by Fortier in fig. 5. In this case, had the cultivation begun as early as the second, instead of on the fifth, day after irrigation, the loss of water would have been materially less than is shown. The increase in efficiency of mulches with depth, from 1 up to 4 in., has been stated on p. 174. Fortier's observations along the same line, for arid conditions in California, show that the efficiency of earth mulches increases materially to a depth of 10 in. and probably beyond, with ratios for the first fourteen days after cultivation as follows: For no mulch, and for mulches of 4, 8, and 10 in., the losses were ·72, ·20, ·09, and ·02 in. of water respectively. It should be said that in these determinations the water was applied at the surface in the case of no mulch; but in the other three cases, after the water had been applied and was absorbed by the soil, the surface was covered to the required depth with a dry earth mulch. No water, therefore, was lost in developing a dry mulch after irrigation, and the results show the maximum of efficiency which would be possible, such as might occur if the water were applied by methods of sub-irrigation, where the surface soil was never wet.

Methods of Applying Water in Irrigation.—To handle water in a given field, after it has been brought to it for irrigation, so that it shall be applied at the right time, in the best amount, without unnecessarily washing or puddling the soil or injuring the crop, and with the minimum loss of water, requires a thorough acquaintance with the soil conditions, close observation, good judgment, skilful manipulation, and abundant patience after the surface of the field has been put in excellent shape to receive the water.

Whatever method of applying water in irrigation is adopted it is important that small inequalities of surface relief should be removed by some method of grading. Otherwise some portions of the field will receive too much water, while others will not receive enough. The fact

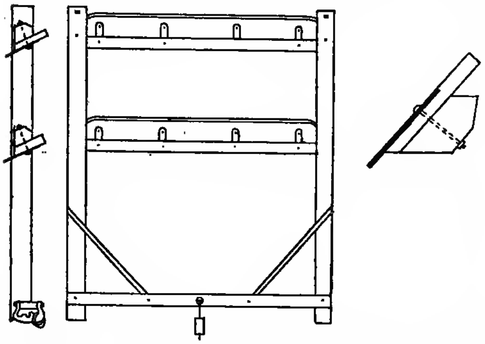


Fig. 6—Showing construction of simple device for levelling fields preparatory to irrigation.

that soils under arid conditions, where irrigation is most practised, usually show little differentiation between soil and subsoil permits even extensive cutting down of elevations and filling of depressions without serious impairment of productive capacity.

There have been many forms of levellers or graders of simple construction devised to meet immediate needs in fitting the surface for irrigation, one of which is represented in fig. 6. (See also art. LAND LEVELLER, where an illustration of the Shuart land grader is given.)

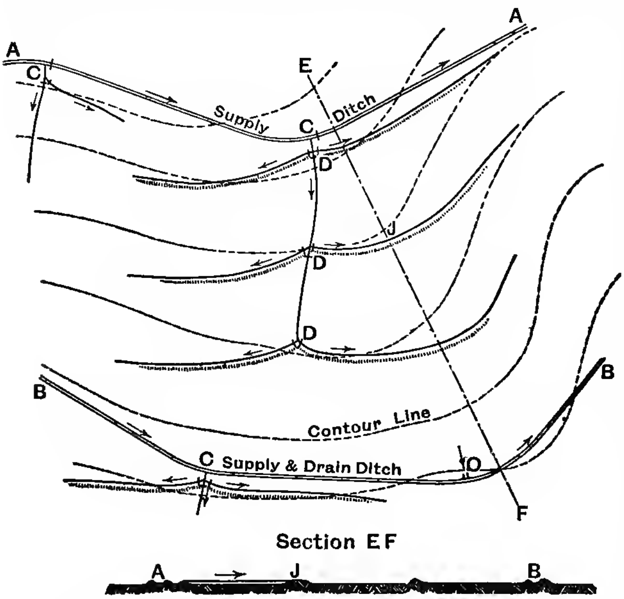


Fig. 7.—Flooding on steep slope by contour furrows or ridges (Grunsky).

IRRIGATION BY FLOODING.—There are two distinctly different methods of applying water by flooding. In one the water is allowed to flow in a continuous sheet or thin veil over the surface until a sufficient amount has been applied.

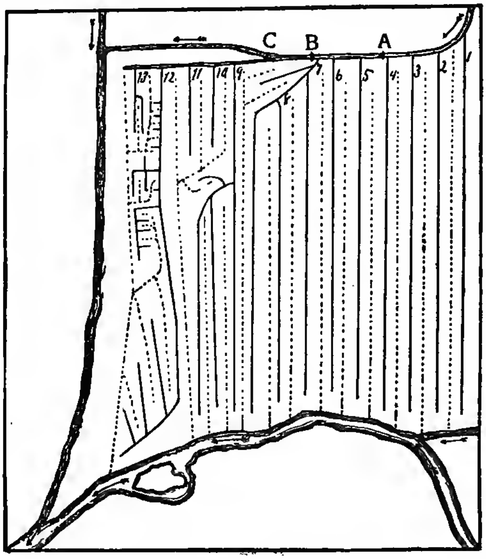
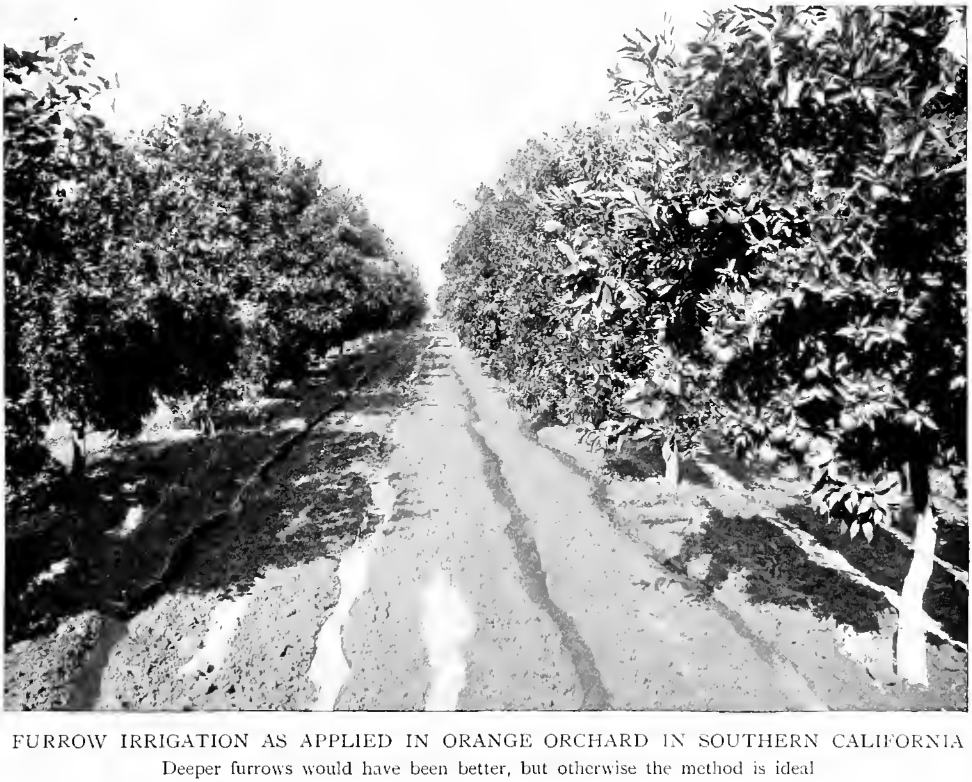


Fig. 8.—Plan of old water meadow, Salisbury, England.

In the other the surface of the field or area to be irrigated is covered at once with a sufficient depth of water to meet the needs at the time. One instance of the first method of irrigation by flooding is represented in Plate, where water is being turned out of a deep distributing furrow by means of a canvas dam seen in the foreground. Parallel furrows extending down the slope of the field at regular intervals of 30 to 50 ft. permit the water to be led from a head ditch over the whole field, flowing in a thin sheet sufficiently long for the desired amount of water to be applied.

Where the slope is more steep, water may be distributed as represented in fig. 7, showing water taken out of the supply ditch A A at C, and led down to be caught behind distributing furrows or ridges D D D, which are given just sufficient incline to permit the water to flow each way, and be distributed to the intervening space below by overflowing the crests of the levees. In other cases, such as the Italian and old English water meadows, fields are laid out in parallel beds or ridges, as represented in fig. 8, where water is led out of some head ditch, A, B, C, into distributing ditches 1, 2, 3 to 13, represented by solid lines in the illustration, which occupy the crests of ridges along the whole length of which the water overflows either way to pass down the incline

IRRIGATING A WHEAT FIELD BY FURROW FLOODING



FURROW IRRIGATION AS APPLIED IN ORANGE ORCHARD IN SOUTHERN CALIFORNIA
Deeper furrows would have been better, but otherwise the method is ideal

and be led away, by the drains represented by the broken lines in the drawing, into some stream or lower-lying ditch or canal, which may become a distributing ditch for a lower series of beds.

The second type of flooding is much used in field irrigation where the slopes are small and the surface uniform, and particularly where crops which closely cover the ground, such as alfalfa, clover, small grains, rice, and cranberries, are grown. The principles underlying this method of irrigation are illustrated in fig. 9 and in the diagram which appears in vol. iv, p. 195 (art. Drainage); the latter showing how the principles have been applied on a large scale

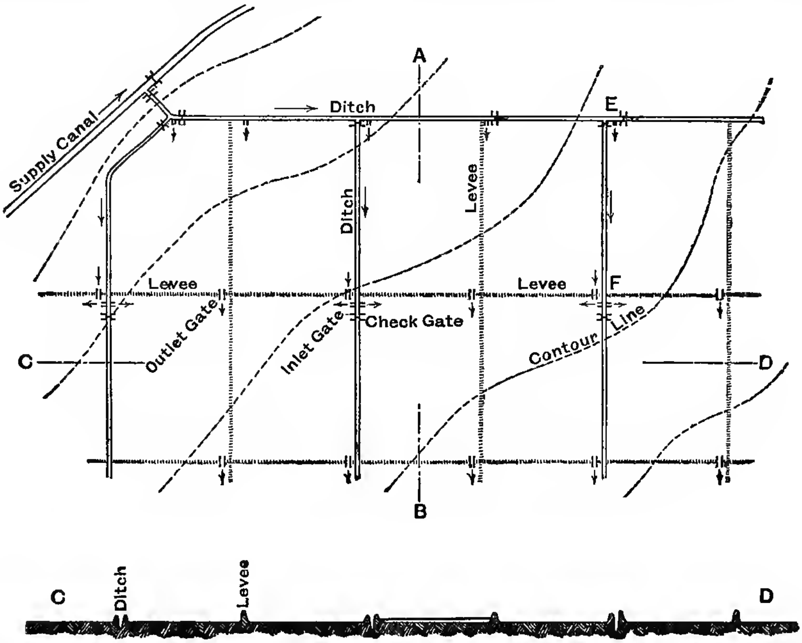


Fig. 9.—Showing the method of applying water by a system of nearly level checks which may be large or small, varying with the slope of the ground.

in rice irrigation in the Carolinas. Here advantage was taken of tidal damming, where the incoming tide holds back the fresh water in the streams sufficiently, so that by opening floodgates water may be admitted to the checks as

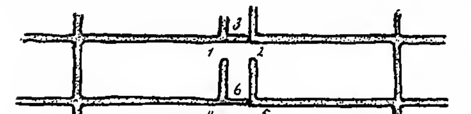


Fig. 10.—Flooding by checks in garden irrigation.

desired, and drawn off again with the recession of the tides.

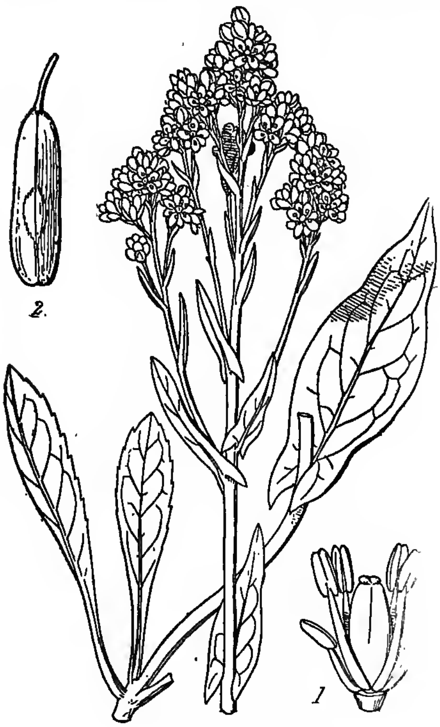
In garden irrigation this method of applying water is sometimes used, as illustrated in fig. 10, where, by cutting out the soil dam at 7, water is admitted to 4 and 5, and then, by removing that at 6, it is admitted to 1 and 2, &c., the entrance to the checks being closed with a little soil as they are filled, and water retained until it has time to be absorbed.

Furrow Irrigation.—For nearly all intertilled crops, whether of field, orchard, or garden, where planting is in rows, furrow irrigation, as illustrated in Plate, is best, and when the water is rightly handled it may be applied with the least danger of injury to the soil and with high economy. In the irrigation of such crops as potatoes, sugar beets, cane, maize, celery, and cabbages, where planting is in rows laid out in the direction to give proper slope, the ordinary cultivation permits furrows to be formed between the rows and the water readily applied.

[F. H. K.]

Isatis, a genus of Cruciferæ, comprising about thirty species of erect, tall, branching annuals or biennials. Several of them are in cultivation as garden plants, *I. glauca*, with milk-white leaves and tall branched heads of yellow flowers, being most effective in the woodland or wild garden. The best-known species, however, is *I. tinctoria*, Woad, with which the ancient Britons used to stain their skins; and although it is still grown in some parts of England for its dye properties, for instance near the town of Wisbech, formerly an impor-

tant centre of the English woad industry, and in Lincolnshire, indigo and coal-tar substitutes have almost supplanted it as a dye. The leaves of the plant are crushed under rollers, and the pulpy mass is then made into balls and dried in open sheds. They are then ground into powder, sprinkled with water, and allowed to ferment for about nine weeks, being frequently



Woad (*Isatis tinctoria*)

1, Pistil and stamens. 2, Fruit.

turned over and sprinkled during fermentation. The woad is then ready for the dyer. [W. W.]

Isinglass. See GELATIN.

Italian Rye Grass. See RYE GRASSES.

Italy, Agriculture of. See EUROPEAN AGRICULTURE.

Itch.—There are many causes of irritation of the skin, or itching, but *the* itch means a skin trouble caused by parasites of the sarcoptic or symbiotic families. The itch of man, the scab of sheep, and the mange of horses, cattle, swine, dogs, cats, and other animals are alike in their origin, namely the irritation caused by mites which either feed upon the surface or burrow under the cuticular layer, but each species has its own particular mange mites or itch insects, and the scab of sheep does not cause the mange in horse, dog, or pig. Transmission or infection between individuals of the same species is easy, hence we find that both domesticated and wild animals are affected in large numbers, and sometimes to such an extent that they perish from irritation and want of sleep. The gregarious animals, as wild ponies, suffer most: the shy fox and marten, which only come together at mating periods, the least; but a hunting country is often spoiled by foxes suffering from mange, whole families growing up with the disease. Of the very few specifics known to man, there is one for the itch, and it is sulphur. The difficulty is in its application to long-haired or woolly-coated animals; and the habit of females of burrowing to deposit their eggs at the end of long galleries in the skin makes it necessary to employ a second dressing in all cases to ensure the destruction of the recently hatched, before sexual maturity is reached and reproduction possible. See also SCAB and MANGE. [H. L.]

Itch Mite.—This parasite is described in the article SARCOPTES SCABEI.

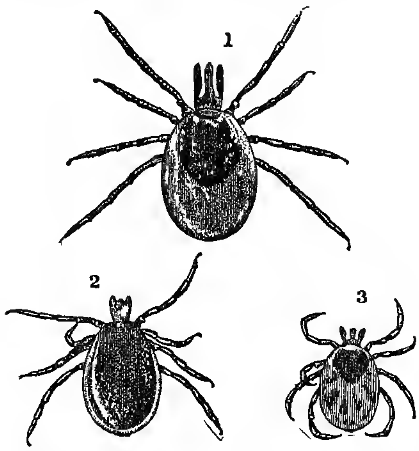
Ivy, Damage done by.—Ivy (*Hedera Helix*) is a non-parasitic plant, which obtains its nourishment mostly from the soil by means of its subterraneous root-system, while the rootlets that attach its climbing shoots to the stems or walls up which it ascends are mainly mere tentacles for mechanical support. But if allowed to grow unchecked upon the stems and branches of timber trees it soon clogs the lenticels of the bark and tends to constrict the stem and prevent its normal enlargement in girth; and thus it then directly interferes with the wellbeing of the individual trees to which it is attached, and may even spoil the growth of the crop as a whole. Except where specially desired for ornament, therefore, it should be cut through close to the ground and partly torn away from the stem; and this operation should be repeated as often as may be necessary to preserve the trees from a fresh growth of ivy shoots. [J. N.]

Ixodes hexagonus, a common tick which is parasitic on various hosts, more especially stoats, ferrets, and hedgehogs, but it also occurs on sheep, cattle, and other animals. The males are rare, and, unlike the next species, are not generally found accompanying the females on the host. Pairing takes place on the ground. The female varies from 3·86 mm. when fasting to 11 mm. when replete. The shield is heart-shaped and punctate; the body finely hirsute; palpi short and broad, and the tarsi of all the legs are more truncate than in *I. ricinus*. The body is drab-coloured, waxy, and semi-transparent; the shield, legs, and rostrum pale testaceous. The male varies from 3·5 to 4 mm., reddish-brown with paler legs, a punctate shield, leaving a narrow rim around; general form roughly elliptical. It differs from the former in having a shorter spine on the first pair of coxæ. The pupa is 1·7 mm. long; the body pale blue-grey and semi-transparent, with four large posterior dark marks, joined together behind the shield, and smaller ones in front and at the sides. When fully distended it is uniformly brownish-white; legs, shield, and rostrum pale testaceous. The larva reaches up to 1·7 mm., and has a light translucent body, which becomes dark.

A variety of this tick (var. *inchoatus*), which has a light grey-brown body and eight large dark triangular intestinal marks and two small ones near the shield, and with a grey margin in

the female, is very abundant on sheep dogs on the Border, but has not been found on sheep. [F. V. T.]

Ixodes ricinus (Sheep, Cattle, Dog, and Goat Tick).—This is the commonest of the three British sheep ticks. It is also found on cattle, goats, dogs, deer, hedgehogs, moles, bats, lizards, &c. It is the carrier of piroplasmosis of cattle in Europe, and also apparently now and then inoculates sheep with 'louping ill'. The eggs are laid in long masses on the ground. The female when fasting is no more than $\frac{1}{7}$ in. long, but when fully distended (Bottle-nosed Tick) nearly $\frac{1}{2}$ in. long. The colour of the body is deep orange-red, showing four faint dark intestinal lines behind the shield, light-grey in front



1, *Ixodes ricinus*, ♀ (× 8). 2, *Ixodes ricinus*, ♂ (× 8)
3, *Ixodes hexagonus*, ♀ (× 4)

both above and below; but the colour varies with distension—specimens may be olive-green, dark-red, or black, and when ready to lay eggs there are irregular yellow streaks on the back and sides; legs, shield, and rostrum deep-brown. The male is about $\frac{1}{8}$ in. long, dark-brown to black with a brownish-white margin. The nymph when distending is opaque, white to blue-black, and finally black. The larva is a little more than $\frac{1}{20}$ in. long, transparent, with olive-green intestinal markings. The larval, or 'grass', or 'face' ticks, as they are called, are found on the head of sheep; the adult females, called 'bottle-nosed ticks', on the belly, udder, and bare parts. The larva when replete falls to the ground, as also does the nymph, and there the casting of the skin takes place. On the dog this tick is frequently found amongst the long hair, and was formerly known as *Ixodes plumbeus*. Megnin records this tick in the nymph stage on horses, and it also attacks man. See next article. [F. V. T.]

Ixodidæ (Ticks).—These acari are parasitic on animals, birds, reptiles, and man, &c. They are of considerable importance to the farmer, stock-breeder, and grazier for two reasons — firstly, they take away blood and cause irritation, and secondly, they are active agents in the spread of certain diseases. In Europe the only proven tick-borne disease is red water in cattle; but in Africa and elsewhere we have others, such as East Coast fever in cattle, malignant jaundice in dogs, heart water in sheep, and human tick fever. These ticks are mainly carriers of minute parasitic protozoa (*Piroplasmæ*), which produce such diseases as red water in cattle.

Ticks occur in this country on cattle, sheep, dogs, ferrets, and wild animals. They have not always single hosts, but the same species may be found on several animals. For instance, *Ixodes ricinus* on sheep, goats, cattle, deer, moles, bats, and even birds. This makes their eradication all the more difficult. Ticks pass through four stages in their existence, namely the egg, larva, nymph, and adult. The females of the true Ixodidæ have their body enclosed in a very elastic skin, thus enabling great powers of distension. The body is partly covered by a hard shield and a false head, which bears the mouth organs. The mouth of the tick consists of a rostrum used for piercing the skin. The rostrum is made up of a hard tube for suction, armed with rows of barbs so as to hold on to the flesh, and also palpi armed with hooks.

The female body swells enormously when gorged with blood. The male is not distensible, but is covered by a shield, with a narrow soft margin around in some cases. Larval ticks can be told by having only six legs, the nymphs and adults both having eight. In the *Argasinæ* (bird and human ticks) the shields are quite absent, and the ticks do not swell much when feeding.

The life-history of a tick is briefly as follows: The eggs are laid by the female in long masses on the ground; they then hatch into small larval ticks, often called 'grass ticks'; these small six-legged larvæ then ascend the vegetation and wait until some passing host takes them away in hair, feather, or on the skin. Some species never leave the host after having once gained a hold, others leave it once or twice to moult their skin on the ground.

The Sheep Tick (*Ixodes ricinus*) leaves its host at each moult; when on the host the larva sucks blood, swells, and drops to the ground; there it casts its skin, and as a nymph ascends grasses, &c., and regains the host; the nymph swells, falls to the ground, moults, and becomes a male or female. The adult females feed and swell, fall off, and lay their eggs. The Red Tick of the Cape passes the first moult on the host, whilst the Blue Tick does not fall to the ground at all.

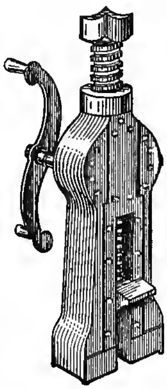
Ticks can go for a long time without blood —their sole food—even over three years. The normal length of life varies: the Texas Cattle Tick may complete its changes in sixty days, our *Ixodes ricinus* in about a year and a half. The *Argas* feed only by night and hide away by day. The method of egg-laying is very peculiar. One sheep tick lays over 2000 eggs.

Treatment for ticks on cattle and sheep consists of either dipping as for scab, or, as is done in Natal, spraying the animals as they are driven between two rows of rails. Grass land and veldt become infested with ticks, and some good may be done by burning off the rough grasses and 'tors', where they shelter. [F. V. T.]

J

Jackdaw (*Corvus monedula*).—This smallest (14 in.) native species of the crow kind is somewhat social, and easily recognized by his grey collar. The untidy stick-nest, lined with feathers, is generally built in a tower, wall, chimney, cliff, or any convenient hole. The three to six greenish eggs are spotted with grey. Jackdaws are chiefly beneficial, destroying large numbers of wireworms and other insects, and removing parasites from the backs of stock. Occasionally they do harm by damaging cherries and other fruit, taking eggs, and filching food from poultry. These offences, however, are minor ones, and the bird deserves protection or even encouragement. [J. R. A. D.]

Jacks.—Jacks are mechanical aids for lifting weights. Every farmer necessarily has a cart jack for raising the cart wheels from the ground so that the axles may be greased or oiled, and it is a foolish risk to attempt to do this without mechanical help. For the comparatively light weight of a cart a simple contrivance of a lever of the first order placed on a convenient standard is commonly used, and is efficient; but where heavier machines, such as threshing engines, have to be 'jacked up' for any reason, a screw-jack is best suited, as considerable power can be obtained in a small and easily portable instrument. These may take various shapes, and the bottle-jack from its convenience in handling is very popular. Jacks can be used for other purposes than for lifting carts and machines, such as lifting buildings which have given way and require under-pinning. The hop dog used to lift hop poles carrying hops at picking time is a form of jack adapted to its special purpose. [W. J. M.]


Screw-jack

January, Calendar of Farm Operations for.—

1. Southern Britain

Arable Farm.—The stubble ploughing ought to be finished this month, and the lea land well advanced, so that it may get well weathered before the time for sowing spring corn arrives. Every spell of frost ought to be utilized for carting out dung from yards, either to be spread on the land or for piling up in a heap for future use.

Threshing corn of all kinds, preparing the grain for market, and disposing of the straw not used for fodder, is one of the principal jobs at this time of the year. This month is reckoned the dead season, and opportunity is taken to carry out all sorts of small improvements and the miscellaneous jobs required to keep the farm in a general state of efficiency: thus road making and mending; grubbing up, repairing, or making new fences; draining, and the cleaning out of ditches which have become blocked; carting and spreading lime or marl in bulk, and so on. Many similar works should be done whenever the ploughing and other important work of the farm is finished.

Live Stock.—Much of the stock is housed, and as this is the coldest time of the year (on the average) the allowance of food must be liberal. Fattening sheep are folded on swedes, kohl-rabi, or other roots, and get a trifle more cake or corn, with a mouthful of dry hay. In ordinary weather they are folded direct on the crop; but if there is excessive wet and the land is rather sticky, then it is necessary to run them temporarily over a grass field and cart the roots to them. Fattening cattle are shut up in yards or tied up in stalls, and require up to 6 lb. of cake daily per head besides roots and fodder. Young stock and dry cows are allowed to run outside continually if the fields have any shelter at all. In the milder climate of the south it is seldom necessary to bring these into the yards or houses, as during a snowstorm a little rough hay or straw put along the sheltered side of a hedge is quite enough to keep them going in most cases.

Pigs must be comfortably housed in an abundance of litter or in a warm yard, as they feel the cold very badly. They must be liberally fed —especially if being fattened—boiled potatoes plus meal making the most suitable food.

Dairy.—On cheese and butter farms the cows are more or less dry and 'resting' at this period, but where the new milk trade is followed there should be a sufficient number of fresh animals coming in to keep up the total yield of milk. There is not so much difficulty in doing this in a southern climate, where a long spell of frost or snow is exceptional; and though the autumn-calving cows are now on the wane and the effects of spring are not yet felt, still the yield should be fairly well kept up. A liberal supply of pulped roots and cakes or meals is necessary, besides the 'chop' and fodder. They should be watered in their stalls, so that they may not be chilled by turning out into the cold air to drink at a muddy pond. Cooking, or even steaming, the food is seldom practised in the south, but all the victuals fed at the ordinary temperature. The pulping of roots and mixing with chaffed straw reduces the bad effects of ice-cold food of this sort.

Hop Gardens.—Dung is carted on to the land and put to the 'hills'; old bines are collected and burnt, or carted to the homestead for litter in the yards; poles are collected and stored up in piles; new ones are cut in the plantations, pointed, and tarred or creosoted; the pole plantations are looked to; old gardens are grubbed up, and delving done in good weather in the regular lots.

Exceptional Crops.—Osiers may be planted this month. Water meadows should be 'drowned' at intervals.

Marketing is at its busiest as soon as the

Christmas influence is past, as everything is now coming to the selling stage: grain, straw, hay, potatoes; fat cattle, sheep, pigs, &c. [P. M'C.]

2. NORTHERN BRITAIN

This is the dullest month of the year, and the one during which we usually have most frost and least growth. The principal work for the teams will be the ploughing of the lea, carting out manure during frost, and taking grain and potatoes to market where these are grown for sale. Advantage should be taken of all periods of frost to empty all courts and dungsteads of their contents, as not only is this work more easily done during frost, owing to the roads being generally good, but, except thrashing and dressing of grain, little other work can be done, except by those in regular attendance on the various classes of stock. Sheep on turnips or pasture will require constant attention to their feet. All new lots should receive particular care at first, as a little extra time spent on paring and walking them through the footbath saves a lot of trouble later on.

If it is intended to put slag, lime, or potash on any land, this is a good time to do so. All of these may be sown by machine if the land is in pasture, or if, when ploughed, it is sufficiently hardened by frost to carry the horse. But no machine is easily drawn on ploughed land in mid-winter, and where it is desired to put these manures on such land they should be applied before ploughing, or during frost. Slag and potash sown now on wheat, which is intended to be sown in spring with grass and clover seeds, very materially assists in giving a good crop of clover. If mixed together in whatever proportions are thought desirable, and a little water added from a watering can as the heap is being turned over, the potash salts will become more or less dissolved, and the moisture will be taken up by the slag, which will be left in a condition very much approaching dry superphosphate. In this state it is easily sown in ordinary weather either by hand or machine. If lime is to be spread from the carts, the shells should be emptied, at some place near where it is to be applied, and where there is a supply of water. If this is not available, water should be carted to it, so as to slake it shortly after it is put down. If this is done it will fall much finer than if the slaking is done by rain or from the atmosphere. It should be turned over on the day on which it is to be applied, and a little water put on any unslaked lumps. If it is to be sown by machine it should be riddled at this time also. By several of the machines now available for the purpose, any quantity from 1 or 2 cwt. to over a ton may be applied, and if more is to be applied, the land can be gone over twice. [J. S.]

January, Calendar of Garden Operations for.—

1. SOUTHERN BRITAIN

Operations in the vegetable and fruit gardens during the first month of the year are necessarily limited to preparations for the future. If trenching and digging have not been already done, no time should be lost, choosing weather that is favourable. During frost, when the ground is hard, manure should be wheeled on to the borders, &c., and worn-out trees felled and either burnt or cleared away. A fire in the garden at this time enables the workmen to destroy all kinds of rubbish, and the ashes are useful as a dressing for the soil. The pruning of fruit trees should be completed before the end of the month, but it must not be performed whilst the trees are actually frozen. Wall trees that require dressing for insect and fungoid pests should now be treated with one of the numerous washes known to be effectual cleansers. It is not too late for transplanting deciduous trees, but it should be borne in mind that the roots when exposed are easily injured by frost. Where frames are available, hotbeds should be prepared for the forcing of such vegetables as asparagus, carrots, turnips, radishes, potatoes, and lettuce. The manure bed when it has settled should be about 2 ft. high, and on this about 6 in. of good light soil should be placed inside the frame. A day temperature of 60° F. and one of 50° F. at night should be aimed at, giving air and even removing the sashes for an hour or so in favourable weather. Early peas succeed best when sown in pots and brought on in a frame. Fruit trees under glass should be pruned and cleaned, keeping the ventilators wide open at all times, unless there is danger of a very severe frost. Vines intended to yield an early crop may now be started by keeping the house close and syringing the canes once a day. A temperature not exceeding 55° will be quite high enough for the first few weeks. Operations in the flower garden and shrubberies should consist of digging, trimming, pruning, and mulching. Tree felling is best performed during a frost. Wood for use instead of coals is at this time of year easily got ready, when the weather is unfavourable for ordinary garden work.

Cuttings of gooseberries and currants may be put in now, selecting plump shoots about 1 ft. long, and removing all the eyes except three or four at the top. They should then be set in a border of light soil, preferably under a wall. Strawberries may be cleaned and mulched with good stable manure if not previously attended to. Rhubarb, chicory, and seakale should now be placed in warmth and kept fairly dark, so as to make the new growth tender and bleached. Where there are greenhouses these plants can easily be accommodated under a stage near the hot-water pipes.

Attention should now be given to plants that are to be forced for the conservatory. A batch of hyacinths, tulips, narcissi, spiræas, Solomon's seal, lily of the valley, *Lilium Harrisii*, *Azalea mollis*, *Hydrangea paniculata*, mock oranges, lilacs, roses, deutzias, and rhododendrons should be put into heat. *Azalea indica* and *Camellia japonica alba* may also be put into warmth to induce the flowers to open early. The annual supply of seeds of vegetables and flowers should not be overlooked. It is advisable to get them from dealers who have a reputation for good quality and purity of seeds. [W. W.]

2. Northern Britain

With the 'turn of the day' and the lengthening daylight, fresh life and energy is soon in evidence in the garden. Before the press of spring work begins, the list of seeds and roots necessary for the season should be made out and the goods ordered on. When these are at hand they can be sown when a favourable opportunity offers, whereas if still to be selected and ordered when the conditions are suitable for sowing, the chances are, ere they can be procured the opportunity is lost, with detrimental results to a profitable crop. Though the modern seed catalogue may be a work of art, the cautious cultivator will discount much of the 'colour' and select only well-proved sorts for his main crops. New and 'improved' varieties, of course, should be tested, but care and judgment are necessary in the selection, as experimental work is usually somewhat costly.

Frequently the weather of this month is changeable, and sometimes severe. When it is too stormy for outdoor work, see that all sheds and outhouses are cleaned and put in order, whitewashing the walls with Irish lime to purify and lighten up the interiors. All tools should be overhauled and put in good working condition against the time they are required for use. Do not keep worn-out and useless tools lying about; destroy all such, and replace them with new ones of the best up-to-date patterns. It is false economy to set costly labour to work with inefficient tools. Insist on the workmen keeping their tools clean and the tool-shed in an orderly manner, having a place for everything and everything kept in its place. Wheel on manure and turn compost heaps in frosty weather, and do spadework when it is mild and open.

Push on the pruning and nailing of fruit trees on walls when the weather is favourable, also prune and clean deciduous trees in the open ground. Do not, however, prune evergreen shrubs or roses meanwhile; it is safer to leave these until the chances of severe frosts are past. Where protecting material has been displaced by storms, see that it is put right, as many plants are lost during the first three months of the year, through the extreme variations of the climate peculiar to these latitudes, by the absence of some slight protection when the forces of vegetation become active.

If tomatoes are grown for market, seed should be sown as early as possible. It is absolutely necessary that a good medium-sized, smooth-skinned variety of bright-red colour be grown; no other will pay nowadays. Sow the seeds in pots of light soil, place these in a warm house, and after the seeds germinate keep near the light. Meantime the interior of the tomato house should be thoroughly cleansed. Wash the glass and woodwork with warm water mixed with paraffin and carbolic soft soap. Paint the walls and hot-water pipes with limewash mixed with sulphur. Remove the surface soil and replace with sound fresh loam. These precautions are necessary when in these days of forced cultivation the number of fungoid and insect pests appears to be on the increase. Prevention is better than cure, and thorough cleanliness will do much towards that end.

Of grape vines for the amateur cultivator and for general use, the best and most easily managed variety is the Black Hamburg. For general purposes the modern method of growing them in single rods, planted from 3½ to 4 ft. apart, or, where the house is used partly for other plants, one vine to each rafter, usually about 5 ft. apart, and pruned on the short-spur system, is undoubtedly the most convenient. Under glass the vines usually start into growth during February, therefore they ought to be pruned as early as possible in January before the sap begins to flow. In young vines the leading growth may be left from 12 to 18 in. long, according to strength and ripeness. Err on the side of shortness to ensure even starting of the buds from the best-ripened part of the wood. The side shoots must be pruned back near to the main stem, leaving only two or three good buds on the spur. Properly ripened vines pruned early will not require any dressing of the cuts, but if opposite conditions exist, the wounds must be dressed with some styptic to prevent loss of sap by bleeding. Probably the handiest, cheapest, and most effective styptic for the purpose is painters' 'knotting'. If there is any suspicion of the existence of insect pests, wash the vines with tepid water in which is dissolved some soda and carbolic soft soap.

As azaleas, rhododendrons, spiræas, lily of the valley, tulips, hyacinths, narcissi, &c., will now force more easily, there should be no difficulty in having the greenhouse gay after this month, and supplies should be placed in the forcing house to meet the requirements of the establishment. [J. Wh.]

Japanese Cedar, a graceful handsome tree indigenous to Japan. See Cryptomeria.

Japanese Larch. See Larch.

Japanese Laurel, a hardy evergreen shrub largely used for decorative purposes. See Aucuba.

Japanese Ponies.—The Japanese ponies form an inferior breed. They stand about 14 hands high, but are weak in the body and long in the leg, and inclined to be weedy. Of late years the race has been greatly improved by judicious crossing with English and American blood.

Jasione montana, commonly called Sheep's-bit and Sheep's Scabious, is a dwarf, hairy annual or biennial dicotyledonous plant belonging to the bluebell order Campanulaceæ, often found wild on light sandy moorland soils and in heathy sheep-walks. This plant is easily distinguished from its allies by the terminal blue hemispheric heads of flowers about ½ in. in diameter, subtended by green leaves (involucre), like a Composite. Jasione might be mistaken for a Composite plant—and Linnæus actually made this mistake—or for a Scabious of the order Dipsaceæ. It is distinguished from a Composite by its many-seeded capsules, and from a Scabious by the anthers being coherent, not free, and not hanging out of the flowers. Sheep's-bit is of no agricultural importance, for though the herbage is eaten, the produce is very

scanty. The hairy leaves form a rosette on the ground, and a few are scattered along the stem. These leaves, which are the edible part, are quite narrow and under an inch in length. [A. N. M'A.]

Jasmine (*Jasminum officinale*, Linn., and *J. grandiflorum*, Linn., nat. ord. Oleaceæ).—There are several species of this genus, but the two mentioned more especially are wild in the north-west Himalaya, in Kashmir, and here and there throughout the cooler tracts of India, as also frequently so in Europe, America, &c., and are extensively cultivated on account of their

Jasmine (*Jasminum officinale*)

sweetly scented flowers. These are employed in the manufacture of jasmine perfume, the process being the production of a perfumed pomade which is subsequently exhausted with acetone. On evaporation of the acetone a reddish-coloured oil remains behind, which smells strongly of jasmine. The species most extensively cultivated in the warmer India, Burma, and Ceylon, for its jasmine-yielding flowers, is *J. Sambac*, Ait.—the Arabian Jasmine—but in place of vaseline being employed in the *enfleurage* the crushed seeds of Sesamum are found better suited to the Indian climate. Jasmine is one of the most important of Indian perfumes. [G. W.]

Jasminum, Jasmine, or **Jessamine,** a genus of erect or twining shrubs with white or yellow salver-shaped flowers (nat. ord. Oleaceæ), comprising 160 species, only a few of which are cultivated as hardy plants in this country. Of the greenhouse and stove species, *J. gracillimum*, Borneo, white scented flowers, *J. grandiflorum*, subtropical Himalaya, white flowers, and *J. Sambac*, Arabia, white flowers, are among the best. The most valuable hardy species are: *J. nudiflorum*, China, the familiar winter-flowering yellow Jasmine; *J. officinale*, probably from Persia, the equally well-known summer-flowering white Jessamine; and *J. primulinum*, China, which bears yellow flowers 2 in. across, and is of recent introduction. These are best suited by a rich loamy soil, and they are particularly useful for covering pillars, pergolas, and porches. Propagation is usually by cuttings placed under glass in July. A perfume is obtained from the flowers of *J. officinale*, and also an essential oil (see above art.). Cape Jasmine is a name for *Gardenia florida*, and *Glesemium sempervirens* is known as the Carolina Jasmine. [W. W.]

Jaundice.—Often called 'the yellows', jaundice or icterus is due to staining of the tissues of the body with bile which has passed into the general circulation of the blood through some temporary and functional disorder of the liver, or owing to structural alteration of the organ. Temporary obstructions due to interruption of the portal circulation, to the presence of crystallized biliary matter occluding the main tube, or to parasitic invasion, would appear more often to result in this tissue staining than actual degeneration or changed structure; many livers with chronic growths never produce jaundice. The symptoms are very marked, yet often overlooked by animal owners. In all animals the white of the eye and the membranes of the mouth and nostrils are more or less stained, from a pale-yellow to a deep-orange colour. Dogs and pigs show the staining also in the softer parts of the feet and between the digits. The urine generally shares in the discoloration; the fæces are pale from absence of bile, and ill-smelling for want of the antiseptic properties which it possesses; the mouth is pasty and sour, the skin dry and harsh, and the coat 'staring'. With the dullness and languor which follows, there is some depression of the heart's action, and a consequent small pulse. Appetite as a rule is in abeyance. In a few cases where the urine is first stained, the above symptoms may not appear until the disease is advanced: this outlet appearing to afford a certain measure of relief.

Treatment. — Associating the malady with dietetic errors as a general rule, we are pretty safe in first giving an aperient. To horses 20–50 gr. of calomel with 4 to 6 dr. of aloes in a ball, following this up with daily small doses of sulphate of magnesia and bicarbonate of potash or hyposulphate, 1 oz. of each being a suitable dose. Cattle profit by aloes and salts in doses of 1 to 2 oz. of aloes, with ½ to 1 lb. of salts, and sheep in proportion; but it is important in their case to ascertain if fluke is the cause, and if proved to be present, the above treatment is not specially suited to the case. Dogs and pigs may be given grey powder or blue pill, and this should be followed up by salines as above. No fatty food should be allowed. [H. L.]

Java Beans.—For many years beans of the Kidney (Phaseolus) type have been im-

ported from the East Indies under the name of 'Rangoon', 'Paigya', or 'Burma' beans, these beans being the produce of cultivated varieties of *Phaseolus lunatus*. Since 1905 considerable quantities of similar beans from wild or only partly cultivated plants have been imported from the Dutch East Indies under the name of 'Java Beans', and have attracted considerable notice owing to the numerous cases of poisoning of cattle, horses, and pigs to which they have given rise, not only in this country, but also in Germany, Holland, Belgium, and France. These 'Java Beans' are of various colours—white, grey, red, brown, purple, black, and mottled. They are usually rather poorer in albuminoids but richer in soluble carbohydrates than the common horse bean, and also contain less woody fibre, the composition being generally somewhat as follows:—

	per cent.
Moisture	13
Oil	1
Albuminoids	19
Soluble carbohydrates, &c.	59
Woody fibre	4
Ash	4

The manure resulting from the consumption of one ton of such beans will have an estimated value (Hall and Voelcker's method) of about 25*s.*

The investigations of Dunstan and Henry at the Imperial Institute have shown that the poisonous nature of these beans is due to the presence, in relatively large amounts, of a glucoside, phaseolunatin, accompanied by a very active ferment or enzyme (emulsin) which, when the beans are moistened with water, decomposes the glucoside with liberation of the deadly poison, prussic acid. The beans vary greatly in this respect, some samples yielding little or no prussic acid, whilst others have been found to give as much as 0·3 per cent of the poison—an amount sufficient to render $\frac{3}{4}$ oz. of such beans a fatal dose for human beings. The white beans were at first thought to be free from the poison-producing glucoside, but further investigation has unfortunately not confirmed this view. Even the 'Rangoon Beans' contain small quantities, although indeed far less than the 'Java Beans'.

The formation of prussic acid is readily detected by the characteristic smell, not unlike that of bitter almonds, which is evolved when the ground beans are moistened and kept for some time in a closed vessel. The greatest caution should therefore be exercised in using for feeding purposes any beans that give rise to this smell when tested in this way. It would appear to be possible to render them harmless by boiling the whole beans thoroughly with water at least twice, straining off the water completely each time (Hendrick). Simple boiling or steaming will not suffice, since, although the activity of the ferment is thereby destroyed, the glucoside is left largely undecomposed, and may afterwards be split up by other ferments in the digestive tract with liberation of prussic acid. Further information on this point is required, and until this has been obtained the use of these beans under any circumstances for feeding purposes must be regarded as risky and inadvisable. [C. C.]

Jay (*Garrulus glandarius*).—This handsome relative of the crows is about 14 in. long, and readily distinguished by his black moustache, and the blue markings on wings and tail. The bulky cup-shaped nest is made of twigs and roots, lined with grass, and usually placed in a tree-fork or among bushes. The four to six eggs are speckled with black on a grey or greenish ground. Jays are essentially woodland birds, and their mixed diet consists of acorns, beech mast, and other fruits or seeds of trees, together with mice, nestlings, eggs (especially of the blackbird), slugs, snails, and insects (cockchafers, &c.). They do no harm to game. On the other hand, they are a pest to the fruit grower, damaging many apples and plums; nuts

Jay

and peas are also attacked by them. The fruit grower and gardener should keep them in check, but there is no case for ruthless persecution by the gamekeeper. They are unimportant as regards agriculture proper. [J. R. A. D.]

Jersey, Agriculture of.—Although the total area of Jersey is only 27,717 ac., including water, or less than one-third of that of the smallest English county other than London, and its cultivated area is but little over 19,000 ac., the agriculture of the island is of considerable importance. Favoured by a beneficial climate, an aspect gently sloping from north to south, and a soil which, if not strikingly fertile naturally, is admirably suited to tillage and responsive to applications of manure, Jersey is an ideal spot for small holders. The agricultural prosperity of the island, however, is largely due to the great industry and enterprise of its cultivators, who have not failed to put its natural advantages to the utmost use.

The prosperity of Jersey is mainly dependent upon potatoes and dairy cattle, though in recent years the tomato crop, grown largely in the open, as well as in glasshouses, has grown into considerable importance. In 1907, out of a total cultivated area of 19,171 ac., 16,010 ac. were arable, and of this quantity 8577 ac. were under potatoes as a first crop, roots mainly being grown after them in the same season,

except when the land is to have a rest from potatoes, in which case 'seeds' are sown. The importance of forage crops for live stock, and mainly for cattle, in addition to those grown after potatoes, is shown by the growing of clovers and grasses under rotation on 4601 ac., while a small acreage of roots and cabbages was grown apart from potato land, and 3161 ac. were permanent pasture. The total area under corn crops was only 1931 ac., about half being devoted to oats for the farm horses and other stock.

The farms are small, only six being of 50 ac. or more, while the great majority are under 15 ac. In 1907 there were 620 holdings over 1 ac. and not over 5 ac. out of a total of 1886 holdings, not including plots of land under 1 ac. The Agricultural Returns do not give intermediate sizes between 5 and 50 ac.; but the average area is 10·2 ac. per holding. At one time nearly all the occupiers owned their holdings; but this is not the case at the present time, as young Jerseymen who have inherited land have for years past been tempted by the high rent offered for it to let it, supplementing the money obtained for it by earnings in commercial pursuits; and many of them, shrinking from the unremitting and arduous labour in which their forefathers have spent their lives, and in which they have taken part during their boyhood, have succumbed to the temptation. The Agricultural Returns put the area of land farmed by its owners at 31·7 per cent of the total under crops and grass, but do not give the proportions of the occupiers. Rents have risen to extremely high amounts in consequence of the large returns obtained from the production of early potatoes; and Brittany peasants, who have come to the island to engage in the potato harvest, have been eager bidders for small holdings. These men have been accustomed to extremely frugal living, and they can sustain themselves and their families upon profits which would not satisfy Jerseymen. Rents for good potato land commonly range from £9 to £15 per acre, and in an extreme case or two a slope towards the south, suitable for the growing of very early potatoes, has commanded a rent of £30 per acre.

In the season of 1908 the shipments of potatoes from Jersey from the first week in April till the last in July, when the exports ceased, amounted to 53,100 tons, the returns for which on the quay at St. Helier were £356,305. If the area of the crop was about the same as that of 1907, the average yield was over 6 tons, and the average return was over £40 per acre, not including potatoes saved for seed or sales for home consumption. Both quantity and value have been much greater in some previous seasons. Records kept from 1883 show 77,800 tons, shipped in 1907, as the maximum quantity, and £487,642 in 1891 as the highest return, although in the latter year the quantity was about 11,000 tons less than in the former. A few pence over £10 per ton is the highest average price; but growers who pay extreme rents for specially favoured plots obtain much higher averages, as the earliest shipments are commonly sold at between £25 and £30 per ton. The expenses for manure and labour, as well as for rent, are extremely high, the total in many cases being £30 per acre, and in some much more. The shipments of tomatoes in 1907 amounted to 2528 tons, valued at £78,331.

Other important returns are those of the famous Jersey cattle, which are exported to all the civilized countries of the world, and those of dairy produce, chiefly butter. The number of cattle in 1907 was 11,968, a large number for the acreage. The pigs numbered 5012, and horses 2347, while sheep amounted to the insignificant number of 162.

The glasshouse industry of Jersey is small in comparison with that of Guernsey, but still is a valuable asset to the wealth of the island. Grapes, tomatoes, potatoes, French beans, and peas are the principal crops raised in the structures, some of which are heated, and others cool houses. Outdoor fruit and culinary vegetables other than potatoes are much less grown than they were in former times. [W. E. B.]

Jersey Cattle.—The cattle in the island of Jersey stand out from all other breeds of cattle in two particulars—(1) that in purity of descent they are *facile princeps*; (2) that the milk yielded by the cows contains a larger percentage of fat than that from any other breed in Great Britain. It is obvious that this richness of milk is connected closely with the purity of the breed, which latter is accounted for mainly by the fact that from its insular position Jersey has been able to control the importation of animals from without, and so maintain that purity, which is so unquestionable that even now, after the lapse of forty-two years, no cows in the island are disqualified for entry in the herd-book on the ground of being cross-bred. Three other causes, however, contributed to make the Jersey cow what she is to-day: (1) Jealousy of the French, who in former days exported Brittany cows to England, where they were sold as coming from Jersey; (2) the Constitution of the island, which enabled the States to pass Acts of Parliament without consulting the English authorities; and (3) the careful attention given to the milking and butter-producing qualities of the cattle by the farmers and breeders on the island.

The first Act of the States of Jersey for prohibiting the importation (amongst other things) of cattle from France was passed in the year 1763. This was followed in 1789 by another Act, in the preamble to which it is stated that 'The fraudulent importation of cows, heifers, calves, and bulls from France having become a matter most alarming to the country . . . in that it menaces with total ruin one of the most profitable branches of the commerce of this island with England, the States have judged it necessary to enact', &c. Then follows various articles prohibiting the introduction of cattle of every sort from France or the adjacent islands under severe penalties, amongst them being the killing of the confiscated cattle. In the same Act regulations, under heavy penalties, were passed for compelling the masters of vessels to report all particulars of cattle they had on board—their numbers, the names of the breeders, and the

consignees, and to exhibit the Governor's passport to the harbour master before leaving port. Thirty-seven years later, in 1826, another Act of the States was passed containing even more stringent regulations, the introduction to which is as follows: 'The export of cows from this island into England being a branch of commerce advantageous to the country, and the superiority of their quality to those of France having shown the necessity of preserving the original breed, of avoiding any foreign mixture, and of preventing the frauds which might be practised by introducing into England French cows as being cows of the island, the States', &c.

Finally, in 1864 a further Act, which is the one now in force, was passed, governing and regulating the importation of cattle into the island, under which animals, if alive, can only be brought into the harbour at St. Helier, and then only for immediate slaughter. In the early days cattle might be imported from England for breeding purposes, but two lots only were so imported, a few Shorthorns and Ayrshires. The results, however, of the crosses with the pure Jerseys were considered so unsatisfactory by the island breeders that the cattle and all their offspring were slaughtered.

As to the origin of the breed, all the authorities seem to be agreed that the cattle in Jersey originally came from Normandy, although in appearance the Brittany cows are much more like the Jersey. It may be that the Jerseys are descended from those cows which were left on the island when it was first severed from the mainland, but this is only a matter for conjecture, and there is no authority in support of it. One thing is, however, pretty clear, that towards the end of the 18th century the Jersey farmers considered their cattle far superior to those on the Continent; and that this opinion was not wrong is shown by the fact that the cattle dealers in England tried to pass off French cattle as coming from the Channel Islands. The old writers Quayle, Gerrard, Inglis, and Stead all mention this circumstance, but otherwise they do not throw much light on the trade done in Jersey cows with England.

That Jersey cattle were until recently, and indeed still are, called Alderneys is explained by the fact that for a good many years the Channel Island steamers used to call at Alderney last on their voyages to England, from which they got to be known as the Alderney Packets, and as a natural consequence the cattle on board were called Alderneys.

Characteristics. — The earliest writers on Jersey cattle consistently mention the superior milking and butter-yielding properties of the breed, but in other respects the cattle in those times were not remarkable. In colour they appear to have differed little from what they are to-day, the fashion of breeding whole-coloured silver-greys and fawns, which obtained during the past thirty years, having fortunately died out. In appearance, however, they were unlike the present-day cattle; the description of them by Col. Le Couteur in the Royal Agricultural Society of England Journal for 1845 showing that the farmer 'was content to possess an ugly, ill-formed animal with flat sides, wide between the ribs and hips, cat-hammed, narrow and high hips, with a hollow back', although with all these faults 'she possessed the head of a fawn, a soft eye, an elegant crumpled horn, small ears, yellow within, a clean neck and throat, fine bones, a fine tail — above all, a well-formed capacious udder, with large, swelling milk veins.'

To show how the modern Jersey has been evolved out of the animal described above, we must go back to the year 1834, when Col. Le Couteur was secretary to the Royal Jersey Agricultural and Horticultural Society, which had been founded the previous year. In that year a scale of points was drawn up for the guidance of the judges at the agricultural shows, dealing almost entirely with the external appearance of the animal, and apparently disregarding her milking qualifications, only four marks out of twenty-seven being allotted to the udder, teats, and milk veins. This scale of points, and a more elaborate one drawn up in 1875, have been adversely criticised on this account—in the opinion of the writer wrongly. The cattle through long years of careful breeding for milk had, as Col. Le Couteur wrote, well-formed capacious udders, &c. &c., but to get them into greater favour in England an improvement in their general appearance was absolutely necessary. In order to effect this improvement the scale of points regulating the judge's decision (and up to quite recent years all animals were judged individually on the scale of points) was so drawn up that there was no possibility of overlooking those characteristics of the animal which stood in need of amendment.

As a matter of fact, however, both in the show rings and in the herd-book examinations a condition precedent to 'scaling' a cow for a prize, and for entry in the herd book, was the absolute necessity of its having a good-shaped udder, well-placed teats, and good milk veins.

Herd Book.—Thirty-two years after the introduction of the scale of points, in March, 1866, the Jersey (Island) Herd Book was established in connection with the Royal Jersey Agricultural and Horticultural Society. Two years subsequently it was 'resolved to maintain the Herd Book as a distinct institution'.

In starting a stud, herd, or flock book there must at first always be a difficulty in finding, or rather obtaining, a guarantee of the purity of the stock to be entered, and inspection must necessarily in the early days form the principal guarantee that the animals accepted for entry are pure-bred, and worthy representatives of the particular class they belong to.

In Jersey the case was different. All the cattle in the island could be accepted as pure-bred—a condition which still holds good—and therefore inspection was resorted to, not for the sake of admitting animals, but for keeping them out of the herd books. Every animal before it could be entered had to be inspected, and unless it satisfied the Committee and herd book judges —no matter what its ancestry—it was rejected. Bulls, too, had to be shown with their dams, so that the dairy qualities of the dams could be taken into account before allotting a bull his number.

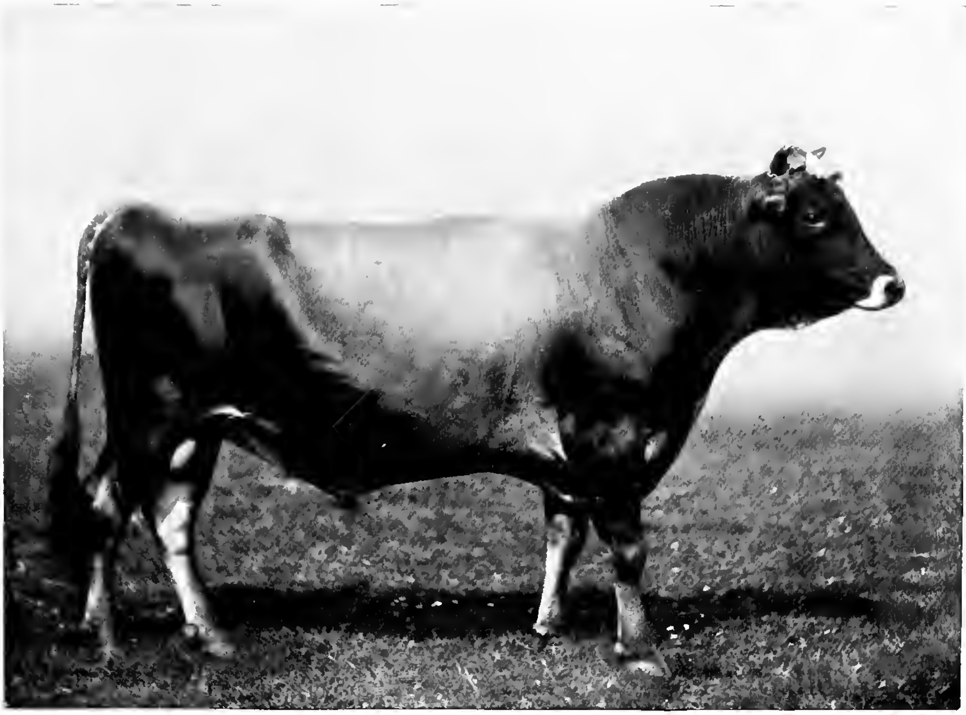


Photo. G. H. Parsons.

JERSEY BULL—"ALFRISTON'S PRIDE"

1ST AT THE R.A.S.E. SHOW, 1908

Photo. G. H Parsons.

JERSEY COW—"LADY VIOLA"

1ST PRIZE WINNER AT THE R.A.S.E. SHOWS, 1906, 1907, AND 1908

These conditions still hold good; but as the system in force now is so good, it may be as well to give the chief points governing the admission of stock into the herd book. These books, which are published from time to time, consist of two sections—foundation and pedigree stock. Animals the produce of non-registered parents can only get into the foundation stock section, but the produce of any stock registered either in the foundation or pedigree sections is eligible for entry in the pedigree division. Before, however, any animal can be admitted into the herd book and given a number in either section, it must be passed by the herd-book judges. These examinations take place at different times of the year and in various parts of the island. Five or six judges usually are present, but only three are in the ring at one time. If a judge knows any of the animals he steps out of the ring, when his place is taken by another. Two qualifications are given—'commended' and 'highly commended'; animals failing to get either of these commendations are rejected. No female is examined until she has had a calf, and all bulls must be shown with their dams. Calves are registered when they are born, and the certificate of registration decides which section of the herd book they are eligible for, when they come up for examination.

Such, shortly, are the conditions that regulate the island herd book—conditions, however, which, except in a small isolated district like Jersey, would be very difficult to carry out, excellent as they are.

The writer has been present at the herd-book examinations in Jersey, and can therefore testify to the fact that no animal with a bad udder, teats, &c., could get a number allotted her, however good she might be in other particulars.

Turning now from the island, to the English breeders of Jerseys, the English Jersey Cattle Society was founded in 1878, the first volume of the English Herd Book being published in the following year. It was of course impossible for the founders of the society to be as strict as the island breeders were in accepting entries for the herd book; but the greatest care was taken in admitting animals, and subsequent rules and regulations passed from time to time have ensured that all animals entered have unimpeachable pedigree tracing back to island ancestry.

For several years at the agricultural shows held in England, only classes for Channel Island cattle were scheduled, the result being that Jerseys and Guernseys competed against one another. The entries of Jerseys, however, became so numerous, that in 1871 the Royal Agricultural Society of England gave separate classes for Jersey cows; and from that time up to the present these classes have always been well filled, both at the Royal Agricultural Society's shows, and at those other county shows which have followed the lead set them by the premier society.

It must not, however, be supposed that Jerseys only became numerous in England after the starting of the English Herd Book and the encouragement given to them at the various agricultural shows, as before those times there were several well-known herds existing in England of unimpeachable pedigrees which formed the foundation of the English Jersey Herd Book. These animals were principally kept for their dairy qualities; but as the classes for these cattle at the shows became more numerous, their general appearance seems to have occupied the attention of the judges, and fancy points (now fortunately ignored), such as black tongues, black thumbmarks in the ears, and whole colours (silver-greys being preferred), received far more consideration than they deserved.

It must, however, be admitted that, with few exceptions, the Jersey cows did not meet with much approval from the farmers in England, the chief objections urged against the breed being its inability to put on flesh, and the yellow colour of the fat in the carcass.

Butter Tests.—In order, therefore, to demonstrate the practical value of the Jersey, butter-test competitions were started by the English Jersey Society at the instigation of the late John Frederick Hall, one of the members of the Council, and afterwards president of that Society. The object of these competitions was to ascertain the quantity of butter obtainable from the milk of a cow in a given period of time (twenty-four hours being the time specified) by the practical test of the churn. They were first held in 1886, and have been continued ever since, with slight alterations, the period of lactation, *i.e.* the time the cow has been in milk, being taken into account, as well as the weight of butter made, in giving the prizes, which are awarded on a scale of points. Commencing with only a few entries, the butter-test trials have now grown into important classes at the following shows: Royal Agricultural Society of England, the Bath and West of England, the Royal Counties, the Tunbridge Wells, the Tring, the London Dairy Show, and the shows of the Royal Jersey Society held at St. Helier. Similar trials, but on more extended lines, have also taken place in America, notably at the Chicago and St. Louis Exhibitions, and in every instance, both abroad and at home, the results have been the same, and have shown that the Jersey is the best and most economical cow for butter production. The quality of her milk is the richest, about 18 to 19 lb. of milk only being required to make 1 lb. of butter, while for sustaining her flow of milk the Jersey cow has no equal. The average yields of butter which may be expected from Jersey cows in a year are given in 'Jersey Cattle, their Feeding and Management',[1] as follows: Cows under five years old, 260 lb.; cows five years and over, 320 lb. As milking cows, their yields average from 400 gal. as heifers to 900 gal. as cows, though of course there are herds where these figures are exceeded.

The average weight of the Jersey cow is about 850 lb. In England they are apt to grow coarser in bone and heavier than on the island of Jersey, which has been attributed to the fact that the island is on a granite forma-

[1] Jersey Cattle, their Feeding and Management. 1908. Veritas & Co., London.

tion. Being essentially dairy cattle, they do not pretend to be of much use to the butcher—indeed a Jersey cow showing an aptitude to fatten would be discarded as a useless animal, the conformation of the dairy cow being opposed to the putting on of flesh. The beef, such as it is, is said to be very rich, the fat being yellow. Heifers usually have their first calf at two years old. The feeding of the Jersey differs somewhat in the island and in England, mainly because of the climatic conditions and the different methods of farming, the soil in Jersey being perhaps as good as can be found, while permanent pasture is not plentiful. In Jersey the stock are tethered on grass or clover in summer, being moved at frequent times in the day. They always lie in at night. In the winter, hay, bran, and mangels are the principal foods, though of later years, in the more advanced herds, crushed oats and cake are added. In England, Jerseys can be treated like any other milking breed, except that, as they are not wanted for the butcher, the concentrated foods given need not be so rich, a full allowance for a Jersey cow being about 8 lb., made up as follows: 3 lb. crushed oats, 3 lb. bran and meal, 2 lb. cotton cake.

The calves are usually taken away from their dams soon after birth, and again, not being wanted for the butcher, are not fed on foods suitable for fattening. A Jersey calf if fed on forcing lines will never develop into a good dairy cow. The usual course of feeding calves is to give new milk for the first month, then gradually to reduce the new and add separated milk, until the calf is being maintained on separated milk only. This may be given with advantage for six months. Good sweet hay and roots, crushed oats and bran, will be found the best foods.

In constitution the Jersey is sound. There is no tuberculosis on the island; animals therefore which fall a victim to it in England must be taken to have contracted the disease after leaving the Island. Like all heavy-milking cattle, Jersey cows require better and more careful attention than poor milkers, as the drain on the system is proportionately much heavier. This is frequently forgotten by farmers who buy one or two Jerseys for the improvement of their milk and then complain that the animals are delicate.

The total number of cattle in Jersey may be put at a little over 11,000, of which 6000 are cows and heifers in milk. In England it is impossible to give the numbers accurately; but as there are over 500 members of the English Herd Book Society the number of pedigree Jerseys in England will not be far short of nine or ten thousand.

There are no special markets for Jersey cows in England, the trade being usually done through dealers in the island and in this country. Pedigree sales of Jerseys are held frequently in different parts of England, but usually these are confined to the particular breeder's herd. The export trade from Jersey is considerable: England takes about 1000 animals every year; Denmark has lately reached about 900; while the United States imports for 1907 reached 461. About 100 are sent annually to France. [E. M.]

Jersey Creamer. See DAIRY APPLIANCES.

Jersey Pigs are not probably amongst the finest specimens of the porcine tribe. This may be due to their descent, to the fact that farmers and landowners in Jersey pay so great attention to their lovely cattle and to the cultivation of fruits, early potatoes, &c., that little time remains to be devoted to the more humble pig. Of late years successful attempts have been made to improve the country pigs in the island by the importation of Middle White boars from England, but even now there is room for improvement in the early maturity of the general run of local pigs. Besides the above, the mildness of the climate may have a considerable effect on the quantity of pork eaten on the island, as it is well known that the inhabitants of countries with colder climates are compelled to consume a considerable amount of fat, either as pork or in some other and perhaps less pleasant form, as in Iceland. [S. S.]

Jerusalem Artichoke.—This is a perennial Composite plant (not an artichoke) which belongs to the Sunflower genus. See ARTICHOKE.

Job's Tears (*Coix Lacryma-Jobi*)

1. Male flower.

Job's Tears (*Coix Lacryma-Jobi*, Linn., nat. ord. Gramineæ).—This remarkable cereal was perhaps one of the earliest cultivated plants

Photo. G. H. Parsons.

TWO-YEAR OLD JERSEY BULL—"GOLDEN BEAM"

1ST AT BATH AND WEST OF ENGLAND SHOW, 1908

Photo. G. H. Parsons.

JERSEY HEIFER—"FROLIC"

WINNER OF FIRST PRIZE AT THE R.A.S.E. SHOW, 1907

in Asia. There are at least two widely distributed wild species in India and several very distinct cultivated races. The wild plants have a smooth, polished, very hard spathe around the grain, and this may be either perfectly spherical in shape (var. *monilifer*), or pyriform, or even quite cylindrical (var. *stenocarpa*), and of various shades of colour from pure milky blue-white to chalky-white, pink, brown, or black. Such seeds are largely used as natural beads in ornamenting fabrics, in forming necklaces, and in the production of Japanese (bead) door screens. The cultivated grain, on the other hand, has a soft, mostly straw-coloured, and prominently striated spathe. This has been distinguished by botanists as the var. *Ma-yuen* —a name given in honour of the Chinese general who found it in Tonkin and sent it to his native country as a valuable new grain. It may be here mentioned that the name *Kasi* appears and reappears over the cultivated area of the plant. It is *Ka-si* with the Nagas on the north-east frontier of India, *Kasei* in the Central Provinces, *Kasai* in Gujerat, *Kesai* in Berar, *Kulese* and *Kalinse* in Burma, and *Kosen* in Japan. It is also somewhat strange that the plant seems more closely connected with the Mongolian than with the Aryan or Dravidian races. Its present-day cultivation may be said to be Eastern Bengal, Assam, Burma, the Malay Peninsula, Sumatra, Java, Borneo, Siam, Anam, and South China, and in these countries it occasionally becomes one of the important cereals. [G. W.]

Joint Ill. See Joints, Diseases of.

Joints, Diseases of.—In all joint diseases preventive measures should be adopted and treatment directed to the source of the trouble rather than to any local measures, which can in such cases be only of small value comparatively. Joint ill is a term rather vaguely applied to swellings of the joints, which may originate through infection of the moist and open navel cord soon after birth, or to the infection of the mother through some injury or septic poisoning during or immediately following parturition, to rheumatism, tuberculosis, or other constitutional disease, and in the foot joints of sheep to the ravages of neglected footrot (see Footrot in Sheep). The most frequent of joint ills is that of colts, calves, and lambs in the first month, and may be prevented by early application of a ligature to the navel string, by painting with salicylate collodion, by carbolic acid, or other germ destroyers. The natural withering of the cord shuts the gate against these invaders, but is not always effected soon enough, and besides this, there are lands prone to breed them, and precautions should always be taken.

The painful swellings of the joints which follow on septic poisoning in animals after parturition, are treated by irrigation of the uterus with 1 per cent lysol, or 2 to 3 per cent carbolic acid injections, the joints being fomented with warm water and pain allayed by smearing with extract of belladonna over the enlargements. Rheumatic swellings, which commonly cause acute lameness, are blistered in horses, or a sharp ammoniacal liniment applied, and a half dose of aloes given, as 2 to 3 drams. Rheumatic joint troubles are often distinguished from other affections by their rapid shifting from one limb or joint to another. When rheumatism affects pigs, it more often takes a chronic form, with considerable swelling and tenderness. Besides local applications of ammonia liniment and iodine, swine usually respond to internal doses of salicin or salicylate of soda, which can be given dissolved and mixed with their food.

The use of aperients of aloes and salts is indicated in cattle suffering from rheumatism of the joints, and sulphate of soda in 1-oz. doses twice a day may be continued for a length of time. Inflammation of joints of a traumatic or accidental kind are of frequent occurrence among animals and should never be lightly regarded, because liable to lead to permanent lameness, blemish, and depreciation in value. Cattle lame behind will not fatten, and horses soon become 'tucked up'; but whether a joint suffers by specific disease or by injury causing lameness in a front limb, there is not such a disposition to wasting of the abdomen. An injured joint, if not open and permitting of the escape of joint oil (synovia), should be fomented and packed in a warm wet bandage frequently renewed. At the same time it is good practice to give an aperient. Injuries to joints are very apt to induce fever, and if an aperient is not prescribed the diet should be laxative. After some swelling has relieved tension and pain in an inflamed joint, the case will commonly benefit by cold affusions or a lotion of chloride of ammonium, 1 lb. to a bucketful (2 gal.) of water, constantly renewed on linen bandages. Injury to a joint is not to be measured by the length of a wound, but the depth; hence we find very small punctured wounds the most serious. If the capsular ligament (as the investing strong membrane is called) be punctured, there follows what is known as an open joint. The secreting membrane inside takes on acute inflammation, a saffron-coloured fluid pours out of the wound, high fever follows, and intense pain is experienced, and only animals of some value are likely to be worth treatment. Contradictory as it may seem, a mild blister is often the best remedy, as the swelling artificially caused will help to close the wound. White of egg, chalk and spirit of wine, or whiting and vinegar, are often piled on the issue until at last it seals up; but he who would treat an open joint must have much patience, and be content with a certain amount of permanent enlargement when the animal is again able to use the parts. Horses are best slung in such cases, and fat or half-fat cattle slaughtered before the temperature rises. Open joint may result in anchylosis and a fixed and immobile joint. See also Spavin, Splint, Ringbone. [H. L.]

Judas Tree.—Cercis, a genus of Leguminosæ, sub-order Cæsalpineæ, comprising five species of small trees, natives of South Europe, Asia, and North America. The flowers appear in May and June before the leaves. *C. Siliquastrum*, reddish-purple flowers, the common Judas tree (on which Judas Iscariot is said to have hanged himself), from South Europe and the

warmer parts of temperate Asia, and *C. canadensis*, Redbud, North America, red flowers, are of considerable value in this country as small decorative trees. The flower buds of the latter are used in salads, and the young shoots for dyeing purposes. The remaining species are not hardy. There are varieties with flesh-coloured and white flowers. These plants prefer a rich, deep, sandy soil in a sunny position, and they are best when raised from seeds. [W. W.]

Judging.—The immediate object of judging is to place animals, implements, or other articles in their order of merit as compared with each other. The ultimate object in the case of live stock is to encourage the production of animals of high personal merit, and also from an educational point of view to set before onlookers an object lesson of the type of animal of each variety which ought to be aimed at in breeding. It is obvious, therefore, that the person appointed to act as judge should have an intelligent and thorough knowledge of the desirable characteristics of the particular breed on specimens of which he is called upon to adjudicate. It may also be pointed out that experience in judging is desirable, if not indispensable, where a large number of exhibits of approximately equal merit are brought into the ring. A person may be capable of forming a fairly sound estimate of the relative merits of the competitors when these are few in number, who might feel much greater difficulty in putting a numerous body of exhibits in the order of merit. The difficulty of judging even to one's own satisfaction is liable to be much increased by finding no inconsiderable variety in the types of animals paraded before the judge. This consideration is too much overlooked by onlookers in passing more or less severe comments on the awards made. Another all-important qualification of a judge is that he should be a man of high integrity, not influenced at all by any other consideration than the personal merits of the live stock brought before him.

Attempts have been made to keep officiating judges as much in the dark as possible as to the ownership or identity of the exhibits brought into the ring. It may be mentioned that at the first ploughing matches promoted by the Highland Society in the very early years of the 19th century, the judges were shut up in the house until the work had been completed and the competitors had left the field. Obviously their impartiality was regarded as open to question. Rules have been made and enforced for making it incompetent for any owner or the son of an owner to be in charge of any animal in the ring. But not infrequently the identity of the competing animals is well known to the judges from seeing them at other shows, and besides, the servant in charge is in many cases quite as readily recognized as the owner or any of his family. The elements of integrity and impartiality are indispensable if the work of adjudication is to be satisfactorily carried out, for if these are not present all other expedients can be got the better of where the judge cannot be depended on to 'go straight'. Some societies have adopted the policy of putting in the hands of the judges all the information they possess by supplying them with copies of the show catalogue when they enter the ring. It has been urged as an objection to this plan that if judges have a partiality for particular strains of blood they are apt to be tempted to lay unfair stress on the breeding of some of the exhibits placed before them.

The system of what is termed judging by 'points' has often been advocated, and is described in the succeeding article.

The appointment of a single judge for each class — 'single judging' as it is called — finds favour with many, and has much to recommend it. It throws the full responsibility of each award on the one judge. Of course it cannot prove satisfactory unless the single judge is thoroughly qualified for the task assigned to him. It has the recommendation of deterring incompetent men from undertaking a duty and responsibility for which they are not fully qualified. It is claimed in support of this system that where a single judge had been found to be incompetent at several shows, he would be relegated to the class of the unemployed. The advisability of the plan is open to question where the entries are very numerous, and especially where, as in the horse classes, in addition to the general conformation of an animal the element of soundness has to be closely kept in view. What may escape the notice of a judge acting alone may be detected by another associated with him.

A plan which has long been followed is to appoint three judges for each section, so that if there is a difference of opinion the award is determined by a majority. A modification of this way adopted in some quarters is for one of the judges to stand aside in successive classes, and he is only called in if the other two differ in opinion. Of late, at Highland and Agricultural Society's shows, six judges are appointed for the draught-horse sections, and on the morning of the show it is determined by ballot which three will officiate in the rings for males and females respectively. Two act at a time, the third standing out as above explained.

It has been advocated that a judge or judges should be called upon to give, in the face of the onlookers, the grounds of his decision in each case. Of course this would be impracticable on the ground of want of time, if for no other reason. Its educational value would be a decided recommendation in its favour. The system would enhance the good done by live-stock exhibitions, but we suspect that the ordeal would effectually deter not a few from accepting nomination as judges.

For many years it was the practice of all agricultural societies, whether national, provincial, or local, to offer prizes for agricultural implements, and of course these had to be judged and placed in the order of merit. For a good many years this has been done to only a very limited extent, and it was departed from on the suggestion, if not actually at the request, of implement makers and their agents. In the nature of the case the awards in this department could not be satisfactory unless they were assigned after the implements had been subjected to thorough

competitive trials. Under the old system the use made of the awards given was liable to be abused. For example, cases occurred where a comparatively old machine was for many years industriously advertised as having been awarded the first prize of say the Highland and Agricultural Society, although it had for years been superseded for all practical purposes by new and improved machines of several other makers. Such a state of matters was liable to mislead the unsuspecting public. [J. G.]

Judging Cattle, Use of Score Card.—A score card for judging live stock, as usually prepared, comprises a detailed description of each point of a perfect animal belonging to a breed or class of animals, and opposite the description of each point is placed a certain number, which is intended to represent, approximately, the relative value of the point in question as compared with other points. For example, in a score card for beef cattle the chest may be assigned the number 9, the back 7, the shoulders 5, &c. This would mean that, in the estimation of the person who prepared the score card, the relative importance of chest, back, and shoulders is as 9 : 7 : 5. It also means that a person scoring a beef animal with a score card which valued the chest at 9, could give the animal in question 9 marks for chest only in case he considered the chest perfect according to the description which appears upon the score card. If he regarded the chest as defective in any respect, he would make a deduction from the number 9, giving the chest 8, 7, 6, or whatever number he thought it deserved, taking 9 to represent perfection. In like manner all other points would be taken into consideration, deductions being made from the numbers which represented perfection wherever defects were found. After scoring, the marks assigned by the scorer are added together, and the total shows how nearly the animal comes to perfection. As a rule, the numbers which represent perfection total 100 when added together.

It might appear to some that the use of the score card in the show ring would be the ideal method of comparing animals, and of arriving at a true estimate of their relative merits; but there are several important objections to the use of the score card for this purpose, some of which are noted below.

1. The use of score cards would be a tedious method, and would consume a large amount of time. This is, perhaps, the least objectionable feature of the method.

2. It is impossible to assign numbers to the various parts or points of an animal which will accurately represent the relative importance of these points in all cases. Try as he may, the person who attempts to devise a score card will find that the result of his labours is still open to many criticisms.

3. It is extremely difficult for a judge to say with absolute certainty just how many marks, or what fraction of a mark, he should deduct in the case of each defect he finds as he goes over the animal; and there is probably not one man in ten thousand who could score an animal one day and then score it exactly the same upon the following day, unless forewarned that he should be called upon to score the animal a second time. Further, there is probably no man who can maintain the same standard in scoring a large class of animals—that is to say, he will be either more lenient or more severe in his scoring at the beginning than at the close of the class. The score-card method, therefore, gives more opportunities for inaccuracies in judging than does the ordinary method.

4. In some cases an animal might be so seriously defective in some one point that the judge would be justified in not awarding it a prize; but with a score card the judge is limited as to the number of marks he can deduct, and the animal might score very high in other points, and make a higher total than a more desirable animal. The score card, therefore, hampers the judge, and is likely to give results not in harmony with sound judgment.

5. Generally speaking, the score card is opposed to the most reliable method of judging, in that it compels the judge to deal with each point individually, instead of taking each animal as a whole, and studying the different points in relation to one another.

Notwithstanding its defects as a means of judging animals, the score card occupies an important place in the teaching of stock judging when used with discretion. In nearly all the important agricultural colleges the score card is used for purposes of instruction. It affords a means of getting a large number of students to work at one time. It compels each student to make up his mind whether an animal is perfect, is only slightly defective, or is seriously defective in each point dealt with. If a student does not know whether an animal is defective or not in certain points, his lack of knowledge is brought home to him, and he is interested in hearing the decision of the instructor when the instructor goes over the animal after the class has finished scoring. It trains the student to be systematic and thorough in his examination of an animal, and less likely to overlook defects when working without a score card.

Even for purposes of instruction the use of the score card is limited. If persistently followed, students acquire the habit of criticising animals in a sort of piecemeal fashion, instead of taking them more as a whole. As a rule, the instructor uses the score card merely for teaching the rudiments of judging, and as soon as possible he causes his students to criticise single animals, and to place classes of several animals, without recourse to a score card. It will be seen, therefore, that the score card is useful to only a limited degree, even in the work of instruction. It is a significant fact that while nearly every prominent teacher of stock judging uses the score card to teach the rudiments of his subject, there is probably not one of them who would recommend the score card as a means of judging animals in a show ring.

Sample score cards as used in the Ontario Agricultural College for beef and dairy cattle are appended. They are not supposed to be perfect, but they will serve to illustrate a type of general score card for classroom work.

Beef Cattle

Scals of Points.	Possible Score.	Student's Score.	Corrected Score.
A. General Appearance: 28 points.			
Estimated weight.........lb.			
Weight, according to age	4	......	......
Form, deep, broad, low set, smooth: top line and underline straight ...	8	......	......
Flesh, naturally thickly fleshed. See further under Quality	4	......	......
Quality, bone strong, but of fine texture and clean; skin pliable and elastic; hair soft and thick. All parts evenly covered with firm flesh, which should be mellow to the touch, but not soft and flabby, nor yet in hard rolls or ridges	8	......	......
Style, active, vigorous, but not restless; should show strong character	4	......	......
B. Head and Neck: 12 points.			
Muzzle, broad and clearly defined; mouth large; nostrils large ...	2	......	......
Eyes, large, prominent, clear, and placid	2	......	......
Face, short, with clean-cut appearance	1	......	......
Forehead, broad	1	......	......
Ears, medium size and fine texture...	1	......	......
Neck, thick and short with full neck vein; junction of neck with head clearly defined. In bull, crest well developed	5	......	......
Horns (when present) fine in texture, flattened at base, not more than medium size			
C. Forequarters: 11 points.			
Shoulders, smooth, covered with flesh, well laid back into ribs, compact and moderately broad on top ...	5	......	......
Brisket, prominent and blunt; breast full and wide...	3	......	......
Dewlap, light	1	......	......
Legs, straight and short; arm, broad and well muscled; bone, flat, clean and strong	2	......	......
D. Body: 29 points.			
Chest, deep and wide; fore flanks, full; space back of shoulders well filled, no depression: heart girth large ...	9	......	......
Ribs, long, well arched; thickly fleshed	5	......	......
Back, broad, straight, well fleshed and smooth	7	......	......
Loin, deeply fleshed, coming out full to hooks and carrying width evenly from hooks forward...	5	......	......
Flank, full and even with underline	3	......	......
E. Hindquarters: 20 points.			
Hooks, wide, but smooth and well covered, not prominent	4	......	......
Sirloin and Rump, straight on top, long, wide, well filled between hook and pin bones, smooth	5	......	......
Pin Bones, wide apart, smooth, not patchy...	2	......	......
Tail Head, smooth; in line with back; tail fine, falling at right angles to top line	1	......	......
Thighs, full, deep and wide	3	......	......
Twist, full and deep, nearly as low as flank	3	......	......
Legs, straight and short; bone, flat, clean and strong	2	......	......
Total	100	......	......

Dairy Cattle

Scale of Points.	Possible Score.	Student's Score.	Corrected Score.
A. General Appearance: 16 points.			
Estimated weight.........lb.			
Form, wedge-shaped, as viewed from front and top; straight top line, and great depth of barrel	5	......	......
Quality, hair, soft and fine; skin, of medium thickness, mellow and elastic; secretion, yellow; bone, fine and clean	6	......	......
Style, active, vigorous, showing strong character; temperament, inclined to nervousness, but not irritable or vicious	5	......	......
B. Head and Neck: 8 points.			
Muzzle, broad and clearly defined; mouth and nostrils large	1	......	......
Eyes, large, prominent, clear, and placid	1	......	......
Face, lean and somewhat long, fine between muzzle and eyes	1	......	......
Forehead, broad	1	......	......
Ears, of fine texture, and medium size; secretion, abundant	1	......	......
Neck, thin, rather long, fine and clean at junction with head; no noticeable amount of dewlap	3	......	......
C. Forequarters: 6 points.			
Withers, lean and sharp; vertebræ, somewhat higher than blades ...	2	......	......
Shoulders, light, good distance through from point to point, but sharp on top; smoothly blended into body...	2	......	......
Legs, well apart, straight and short; shank, fine and smooth	2	......	......
D. Body: 22 points.			
Chest, deep, full between and back of fore legs, no depression behind shoulder blade	6	......	......
Ribs, long, broad, and wide apart; well sprung; giving a large, deep barrel	10	......	......
Back, lean, straight, and open-jointed; sharp chine and broad loin... ...	6	......	......
E. Hindquarters: 13 points.			
Hooks, wide apart	2	......	......
Rump, long and wide	3	......	......
Pin Bones, high and wide apart ...	1	......	......
Thighs, thin	2	......	......
Legs, straight, and set well apart; shank, fine and smooth	2	......	......
Escutcheon, spreading over thighs and extending far upwards	2	......	......
Tail, long and fine, terminating in a switch of fine hair	1	......	......
F. Milk Vessels, etc.: 35 points.			
Udder, long, wide, deep, but not pendulous, firmly attached, extending well up behind and far forward; quarters, even and free from fleshiness	25	......	......
Teats, large, uniform, and evenly placed	5	......	......
Milk Veins, large, long, crooked and branching	3	......	......
Milk Wells, large and numerous ...	2	......	......
Total	100	......	......

[G. E. D.]

July, Calendar of Farm Operations for.—

1. Southern Britain

Arable Farm.—This is one of the busiest months of the year, as the harvesting of various crops is in full swing. The making of lucerne and sainfoin into hay should be finished in the early part of the month, to be followed by 'mixture' hay and meadow hay making, and everything in this line should be completed before the month is up. Any forage crop, such as rye or tares, should also be cut for hay, as otherwise it will be ripening soon and be reduced in value unless specially intended for seed. Autumn-sown peas and beans will be ready for harvesting towards the end of the month, and wheat is generally ready to cut before the month is out in genial seasons, so that haymaking and harvesting will be continuous throughout. Root crops need continuous hand and horse hoeing to finish up for the last time, as the tops should be getting a close growth now. Flax may be pulled as soon as the bolls get brown, and the land may be ploughed up for late (broadcasted) turnips or mustard. Where land is bare-fallowed a lot of work is done in July in cross-ploughing or scarifying, and this is also one of the best months for the steam-cultivating of stubbles from which early crops have been removed. This is also a suitable month for clearing out watercourses, as the water will be low now, and there may be an interval for the work between haymaking and harvesting.

Stock.—Milk cows are at their maximum yield in this as well as in the previous month; but the hot weather and dry pastures begin to have effect, and the yield goes down towards the end of the month. Fresh forage, clover, or maize should be coming in to supplement these and help to keep up the flow. Young stock and dry cows will be running at grass without any other feed, but bullocks fattening in the fields must have their full allowance of cake to push them on. Lambs born in spring are weaned in July, and the ewes put into poor pasture for a little. Fattening teggs, either folded on forage crops (catch crops) or running loose on a pasture, should be getting a liberal allowance of cake so as to push on their preparation as fast as possible.

The water supply of all kinds of stock must be seen to, as in this month there is the first tendency to shortage, and the watering places at ponds and streams should be put in order.

Hop Garden.—In dry weather the horse hoe or 'midget' should be kept going between the rows, so that the ground may be kept well stirred and free from weeds. [P. M'C.]

2. Northern Britain

The principal work on most farms during this month will be the making of hay. Rye Grass and clovers should be cut, weather permitting, as soon as the flowering stage has passed. Hay spoils quickest when in the stage in which it is spread out thinly, and no opportunity should be missed to move it from this stage to that of the coil, in which it seldom suffers much damage. As long as the grass is green and living, rain does it little or no harm, but whenever the half-dried stage is reached, every drop of rain washes out of it some portion of the soluble food ingredients, and the warmer the weather the more quickly does this loss occur. Aftermath being made into hay in September is as little damaged by a day's rain as the ordinary crop is by a single hour in July. In Scotland the proper place to make hay is in the coil, and if the crop is allowed to stand in it for a couple of days or so, and exposed for an hour or two to the sun and wind before ricking, its condition will be wonderfully improved. No advantage is obtained by making very large field ricks, from 8 cwt. to 12 cwt. being quite sufficient in most cases. If sticks are used for the centre of the ricks, the crop may always be secured with one or two days less exposure, and in unsettled weather this may mean all the difference between a well-secured crop and a bad one. That is not the only advantage secured by this practice, for ricks with bossins dry much quicker than those without them, so that with them the crop can be earlier stacked, and loss to the top and bottoms by further exposure prevented.

Potatoes will require to be run up during the month, and in order to reduce disease to a minimum it is always a good plan to keep the drill as high as possible. In the earlier districts the raising of the potato crop will be in full swing, and no time should be lost in again seeding the land with whatever is to follow. Turnips will also require to be ridged up, but for them the plough is not absolutely necessary, as a very slight gutter is all that is required, and the cultivator can do this quite well.

Towards the end of the month pastures will begin to get past their best, and stock of all kinds will be all the better of some extra food, which for the present may be limited to a little cake. [J. S.]

July, Calendar of Garden Operations for.—

1. Southern Britain

The character of the weather during this month decides what the gardener's principal duties should be. The heat and drought may be such as to necessitate frequent and heavy waterings, which should be done when possible in the evening. It is a bad practice to water sparingly; when water is given it should be in sufficient quantity to thoroughly moisten the ground, not merely on the surface, but well down to where the principal roots are. Watering, staking, training, and thinning are the most important operations in July. Such things as borecole, brussels sprouts, savoys, and autumn cabbages should be transplanted if not previously ready. Where space is limited and early potatoes are grown, it is usual to plant these important members of the cabbage tribe as soon as the ground has been cleared of potatoes. If the potatoes occupy the ground till August, then the brussels sprouts, broccoli, &c., are planted between the rows of potatoes immediately after the latter have been earthed up.

Celery must be planted in trenches before the end of the month. A sowing of cabbages, including red cabbage for pickling, for plants to be ready for use in the spring should be made now; also carrots, endive, lettuces, radishes, spinach, and turnips for autumn and winter use. French beans may be sown again early this month on a sheltered border to yield a supply in September and October. Should the weather be dry they must be regularly watered, and the soil about them mulched with manure.

Fences of holly, privet, hawthorn, mirobalan, &c., should be clipped before the end of the month. The removal of old worn-out stems from early flowering shrubs such as forsythia, lilac, and rambler roses, if done in July, affords light and air to the shoots that are left. Birds will now be a nuisance where fruit trees are, and steps should be taken to prevent their doing much damage. Raspberries, gooseberries, currants, and cherries are the first to suffer from the depredations of birds, for which nets and the gun are the most certain remedies. Where a fresh plantation of strawberries is to be made, the beds should be at once got ready by deep digging or trenching and the addition of manure. The runners should be planted about the end of the month, treading them well in and watering the soil thoroughly. Keep the grass and weeds from growing about the stems of fruit trees; even old trees in grass-bottomed orchards are all the better for a clear space 6 ft. or so in diameter about the base of their stems. Where roses and fruit trees are propagated by budding, they must be worked before the end of the month.

In the flower garden, seeds of stocks, delphiniums, aquilegias, polyanthuses, wallflowers, pansies, and other spring or early summer blooming plants should be sown this month, either in shallow boxes or in a frame on the north side of a wall. The majority of hardy herbaceous perennials are best when raised from seeds sown at this time of the year and, as soon as they can be handled, transplanted into nursery beds. The layering of carnations will require to be done in July. Seeds of cyclamen, calceolaria, cineraria, and primula for pot cultivation may be sown under glass this month. Cuttings of hydrangeas, if set in pots in July, will flower the following spring. Pelargoniums, bouvardias, heliotropes, and ericas for the decoration of the conservatory in winter should be placed in sunny positions out-of-doors now and liberally treated, but not allowed to flower. [W. W.]

2. Northern Britain

If the weather conditions natural to this month are normal, the early sowings and plantings of garden crops will be making rapid progress. Therefore daily and unremitting attention is necessary to see that none suffer through delay in thinning or earthing up. It is a bad, and costly, practice to allow seedling plants, whether grown in lines or beds, to get drawn and thus weakened. Therefore thin out as soon as the plants can be safely handled. The same remarks apply to the earthing up or staking of any crop. Push on the planting of late batches of winter vegetables. The main crop of celery should have immediate attention. Where the space is limited, three rows 1 ft. apart each way may be planted in a trench; though for first-class produce and for exhibition purposes the plants should be set in single trenches not less than 3 ft. apart, with the plants from 15 to 18 in. apart. Celery repays good cultivation, therefore it must not be starved either for want of good well-decayed manure or water. Leeks can be planted later; these also repay generous treatment. Make successional sowings of spinach, lettuce, and radish suitable for requirements; also a sowing of cabbages for autumn planting. During dry weather, use the hoe freely between the plants. It will pay to run the hoe amongst all crops whether weeds are seen or not, especially so before the small fruits begin to ripen, as frequently during the 'fruit season' the gathering of the crops so takes up time that weeds are apt to get too far ahead.

Where birds are troublesome, see that the strawberry and raspberry quarters are properly netted. Look over the strawberry quarter to see if there are any 'blind' or 'rogue' plants. Mark any of such, if found, with a peg of wood, and have them destroyed immediately the crop is gathered, so that no young plants can be taken from them. Only by vigorously 'roguing', and by carefully selecting the plants from which fresh stock is to be taken, can a high standard or strain of any variety be maintained, and, as only the best pays, do not waste money growing inferior varieties.

Flower beds and borders must have their due share of attention, so that the beauty of their occupants is not marred by any signs of neglect or untidiness. Should any deaths occur amongst the summer occupants, have the blanks made good ere the season is too far gone. Climbing plants ought to have timely attention to prevent the young shoots getting entangled. Too frequently the beauty and effect of this class of plants is ruined by inattention at the early stages of growth.

Tomatoes grown in pots must not suffer from want of water, particularly when in flower and when the fruits are swelling. Where planted out in the border they are less susceptible to changes, but at the same time must not be neglected. Pinch out superfluous growths, and keep a fresh, airy atmosphere to minimize the chances of mildew and other fungoid pests.

When the grapes in the vinery begin to show colour, keep the atmosphere warm and buoyant, with a free circulation of air. See that the border is thoroughly watered, and give at this watering some liquid manure or other stimulant. In most cases this watering will carry the vines through till the grapes are ripened and cut.

Peaches and nectarines which have not been forced will be at the 'stoning' stage, during which they will not show much progress in swelling. This is a critical stage with stone fruits, therefore care must be exercised so that no check or excitement by unduly high temperatures, or dryness in soil or atmosphere, occurs. The borders should receive a good watering,

and the trees be syringed twice daily in warm weather to keep the foliage clean and fresh. [J. WH.]

Juncus. See RUSH.

June, Calendar of Farm Operations for.—

1. SOUTHERN BRITAIN

ARABLE FARM.—Root cultivation is one of the principal occupations of this month. The singling out of mangolds and kohl-rabi will have been largely done in May, as these should be sown early in April, but the second and third hand hoeing require to be carried on, and the corresponding horse hoeing as well. One hundredweight of nitrate per acre should be sowed on the rows immediately the hand hoeing is finished, to stimulate the growth, and a second dose after an interval of a fortnight will pay. Cabbages may be transplanted into well-prepared land out of seedbeds in preference to sowing and singling out, as is done with mangolds or other root crops, advantage being taken of a wet spell for the job if possible.

Clover, lucerne, and sainfoin are all ready for cutting as soon as the month comes in, and not later than the middle of the same. 'Mixture' hay also comes ready, while meadow hay may be left to July. June, therefore, is the great haymaking month of the south. Where forage is grown and removed for hay, mustard or rape may be sown for sheep feed or for ploughing-in as green manure. Fallow land should be having its third ploughing or cultivation during this month. Every piece of stubble as soon as cleared is a suitable subject for steam cultivation, so as to break it up in preparation for autumn-sown crops.

STOCK.—All the live stock is fully on the grass now excepting the fattening bullocks which are being finished off in the yards on green forage and cake. Those fattening at pasture have their cake fed to them there in troughs or pans.

Cows are at their maximum milk yield this month, but generally get a little undecorticated cotton cake to 'correct' the lush grass, and they should have changes of pasture occasionally. All the buildings and cattle sheds should be cleaned out and limewashed now when empty. Sheep washing and shearing should be done early this month if not done before. The animals should be watched for attacks of the maggot fly, especially in showery weather. [P. M'C.]

2. NORTHERN BRITAIN

Over a great part of Scotland the most pressing work of the month will be the finishing of the sowing of the turnip crop. By the time this is done, the first sown part of the crop will be ready to single, and on many farms most other kinds of work have to stand while this is being attended to. Many kinds of work may be delayed somewhat beyond their natural time and yet be easily done later on; but if turnip singling is not overtaken as soon as, or shortly after the plants are ready, it is not only more difficult to do, but the delaying of this operation may seriously reduce the weight of the crop. In order to reduce the weeds and hasten on this work, no effort should be spared to do all that is possible with horses and the various drill harrows and cultivators which are available, and even with these aids it is difficult to keep up with the growth of the crop if the weather is suitable. If resowing is necessary, the drills should always be first harrowed very flat, and then set up again. Sowing should follow close behind the plough, and if the land is dry the drills should always be rolled either with a Crosskill drill roller, or even an ordinary flat one. In all good weather as soon as singling is completed, the horse hoes should be kept going continuously. All weeds are most easily killed when in the young stage, and one harrowing will do as much good now, as two later on. If it can be accomplished, the second hoeing should be given as early as circumstances permit, as when the plants get above a certain size, doubles are difficult to separate, and weeds to eradicate.

Near the end of the month Rye Grass will be ready to cut for hay in the earliest districts, and if the weather is favourable no time should be lost in making a beginning. It is always good practice to begin early if the weather is favourable, if the crop is about ready, and cut as little as possible if unsettled weather sets in. In the making of hay in Scotland good weather is of much more importance than full maturity of the crop, as better hay is usually made from an immature crop in good weather, than from a matured one exposed to much adverse weather. Cattle of all kinds are likely to be fully supplied with good grass, and in most cases will want no hand feeding. Sheep shearing should be carried out in dry and warm weather as opportunities occur, beginning first with wethers and yeld ewes, and finishing up with ewes with lambs. Horses on many farms are insufficiently fed at this time of the year for the work they have to perform. On many farms they are at grass during the night and at work during the day, with little hand feeding unless at midday. If worked a full day they should be liberally hand fed, as they require the night for rest, and if compelled to gather their food, they are sure to fall off in flesh. [J. S.]

June, Calendar of Garden Operations for.—

1. SOUTHERN BRITAIN

Vegetables generally are in the most critical stage of their development in June. They will require to be watered regularly, should the weather be dry, and gross feeders are considerably helped by a mulch of well-rotted farmyard manure or a weekly dose of drainings from the manure heap. A check in growth at this period materially affects the quality of the yield. Watering must be practised in gardens where the soil dries quickly. By keeping the surface loose, evaporation is to some extent prevented, and this is best done by frequently hoeing the soil, the same operation serving to keep down weeds. Should the weather be wet, weeds must be kept under somehow. Thinning

out such things as beet, carrots, lettuces, onions, parsnips, and turnips should be seen to as soon as the seedlings are large enough to be handled. It is better this month to sow cabbages, cauliflowers, and lettuce in rows and thin out to the required distance, as they do not transplant satisfactorily in late summer. Asparagus may be cut until the end of the month, but not afterwards. Seedlings from early sowings of borecole, broccoli, brussels sprouts, cabbage, celery, leeks, and savoys should now be transplanted to their final positions. Although these plants are not easily spoilt by ill usage in transplanting, yet they are all the better when handled with care. Where the time can be spared it is quite worth while to lift them with a trowel, so that a ball of soil remains attached to the roots of each. French and kidney beans may be sown again this month. Potatoes will require to be weeded and earthed up. Tomatoes which have been raised and grown on under glass may now be planted on a sunny border in the open. They do not require a rich soil, water in dry weather and plenty of sunshine being of greatest importance. Vegetable marrows should now be planted on a manure bed.

Fruit trees may require to be watered, and if a mulch of manure is to be given, this month will not be too late for it. When there has been a very free set of fruit, thinning should be resorted to in the case of trees that are likely to be overburdened, or where size and quality are preferred to quantity. The removal of superfluous shoots, particularly in the case of trained trees, should be done this month. Summer pruning, by which is meant the shortening of shoots which are either not wanted or threaten to grow too strong, is performed about the end of this month. The shoots should be cut back to within about 5 in. of their base. This operation must not be performed too early, or the result will be the development of a large number of lateral growths. Insecticides or the hosepipe must be applied wherever the trees are lousy. Strawberries should not be neglected after the fruit has been gathered, but watered and mulched as soon as labour can be spared.

In the flower garden, bedding out and the filling up of borders should be got through as soon as possible after the first of the month. Plants which have been grown under glass may, as far as possible, now be stood out-of-doors. Chrysanthemums should be planted in their flowering pots and placed in a sunny position outside. Roses will require to be kept clean and well watered. Where grapes, cucumbers, melons, and figs are grown under glass, they should now receive close attention, making the most of the sun's heat by careful ventilation and early closing, so as to dispense with that supplied artificially. [w. w.]

2. Northern Britain

In districts where late spring frosts are liable to occur, there is wisdom in deferring the planting out of semi-tender plants until the beginning of this month. As soon as the danger from these frosts appears to be past, lose no time in getting the work of bedding out completed. Begin with the hardiest kinds, leaving the more tender until the last. Before starting the planting, see that all plants are thoroughly watered. This will obviate any necessity for watering the plants immediately they are placed in the ground—a reprehensible practice unless in very special circumstances, as most soils are damp enough at this season, and the artificial application of water tends to cool the soil and gives a chill to the young plants, seriously checking their growth. Do not allow those plants which require stakes to be left to the mercy of the winds, but see that they are secured at once, and have the whole work quickly done and finished in an orderly manner.

The planting of the main crops of autumn and winter vegetables must likewise have attention. Of these, the cauliflowers, broccolis, and early celery are most important.

The latest sowing of peas should be made during the first week. If a later sowing is desired, such can be made up to the 15th, but it is advisable to use an *early* variety for this sowing, which in the generality of situations partakes more of the nature of a 'catch crop', but an invaluable one if it escapes the early autumn frosts. At intervals of ten or twelve days, successional sowings of kidney beans, spinach, radishes, white turnips, lettuces, and small saladings should likewise be made; also a sowing of cabbage for early autumn planting about the middle of the month.

The frames which sheltered the bedding plants could be utilized for the cultivation of vegetable marrows, ridge cucumbers, tomatoes, or any other subjects which require shelter until fairly into vigorous growth.

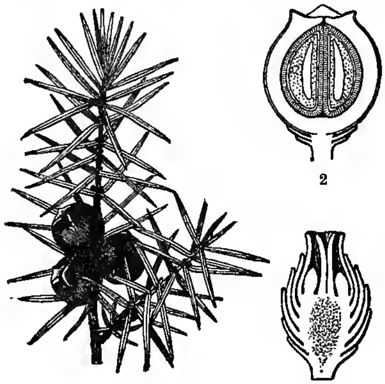
Tomatoes in pots will require daily attention, after the fruits begin to set, as to watering, pinching, and tying. Give weak liquid manure after the pots are filled with roots, to assist the swelling of the fruits.

The thinning of grapes must be taken in hand as soon as the berries are set and about the size of No. 5 shot. In thinning, first remove all the smallest-sized berries and most of those inside the bunch. The outer berries will probably more than fill up the apparent vacancies, and even some of these will require removal. Begin at the low point of the bunch and work upwards. Do not cut away the berries from the shoulders next to the main stalk, as their removal is apt to give the bunch a loose appearance, which is against success in exhibition or market. Never allow the berries to be touched by the hand or clothes, otherwise the 'bloom' will be rubbed off. When thinning the bunches they can be steadied by using a clean, light, forked twig, or a simple pointed stick not thicker than an ordinary lead pencil. Thinning grapes is an art which requires sharp eyes, steady hands, and judgment, along with some practice, to attain proficiency. Maintain a steady, moderately moist, buoyant atmosphere in the vinery, and carefully avoid cold draughts at this period.

Peaches approaching the 'stoning' stage must

not suffer from want of water at the roots. Keep the foliage clean by daily syringings with clean water, and regularly attend to the training of the young growths. [J. WH.]

Juniper (Juniperus) is the only genus belonging to the Juniper tribe of the Cupressineæ or Cypress family of the great nat. ord. Coniferæ (characterized by consisting entirely of needle-leaved, cone-bearing trees and shrubs), the other three tribes consisting of Cypresses, False Cypresses, and Arborvitæ (see CYPRESS and ARBORVITÆ). All the members of this tribe are characterized by having scale-like sessile foliage, usually opposite or ranged in whorls, and imbricate or ranged one above another like overlapping tiles on a roof; but the Juniper tribe also differs from the other three tribes in having the cone forming a globular kind of berry



1, Branch of Juniper (*Juniperus communis*) showing berry-like cones. 2, Longitudinal section of cone. 3, Female flower of Juniper.

in which seeds are enclosed in a sarcous fleshy mass, in place of the cones having thin woody scales as in these latter. The tribe and genus Juniper is easily recognized by its peculiarly strong and pungent odour, and by its globular cones with three to six fleshy valvate scales in which the erect seeds are embedded. The genus consists of thirty-four species of small evergreen trees and shrubs indigenous to the temperate and the cold regions of all the four continents. Only one of these is indigenous to Britain, the Common or Wild Juniper (*J. communis*), which grows freely on heaths and waste lands in most parts of the British Isles. It and the Scots Pine are the only two conifers indigenous to our isles (like the non-coniferous but pseudo-drupaceous Yew, which has foliage like a conifer). Although in Holland its berries are used for flavouring gin (this name being an abbreviation of Genèvre or Juniper), it is here only a useless shrub, a weed rather than a useful plant. A number of exotic Junipers have been acclimatized in Britain for the sake of their foliage as shrubs and trees, but the most important of them all is the Virginian Juniper, also known as the Red or Pencil Cedar (*J. virginiana*), introduced from the south-eastern States of America in 1664. It is a handsome tree of upright habit and rather conical in shape, which grows as well in Britain as in Virginia, a fine specimen at Studley Royal (Yorkshire) being in 1891 70 ft. high and girthing 6 ft. at 5 ft. above ground. Its foliage is variable in form, as the leaves may be needle-like, lanceolate, ovate, or round; while both blunt and sharp-pointed leaves are common on the same branch. Sometimes the leaves are in pairs, and sometimes in whorls; sometimes short, and sometimes long; and they may vary in colour from green to silvery glaucous and purple. Although in America its soft, reddish-brown, cedar-like wood is used for cabinetmaking and turnery, its chief use is as the wooden covering for black-lead pencils. As there is a constant and increasing demand for such fine pencil-wood, it is being cultivated to a fair extent in the German forests (and particularly in southern Germany), where it seems hardy, accommodating as to soil, and reaches a height of 40 to 60 ft. in sheltered situations. Its best growth is attained on a good, deep, porous, light loam resting on a dry subsoil. It can only be relied on to form perfect seed in warm situations, where it seeds freely. The seed often lies over for a year before germinating, but after coming up the seedlings grow quickly, and can be transplanted as yearlings into the nursery lines till big enough to put out. The seedlings are apt to sport, and such sports can later on be propagated by cuttings. Many of these casual spontaneous varieties have been perpetuated with special arboricultural names descriptive of their peculiarities. [J. N.]

Juniper Rust.—This occurs in early summer as yellow jelly-like masses on branches which are swollen or deformed. The yellow masses consist of teleutospores of a rust fungus. It is common on wild and cultivated junipers, including the *Retinospora* forms, and as the bark is destroyed the bushes become disfigured by withered branches. This, however, is only one stage of the life-history, for by means of sporidia it passes to and causes damage to fruit trees—apple, pear, and their allies (see PEAR—PARASITIC FUNGI). Here cluster cups are developed, and give off æcidiospores which infect the Juniper.

Treatment.—The destruction of Juniper will protect the fruit trees. If cultivated junipers are required for decoration, any branches bearing the rust should be pruned off. Spray fluids used on the fruit trees for other fungi will check the rust, but not if the stage on juniper is allowed to become abundant. [W. O. S.]

Junket, a form of dessert made by adding sugar to milk, then curdling the mixture by means of rennet. It is usually taken with cream, and frequently nutmeg or some other spice is added. It is a modified form of 'curds and cream'. Various other forms of sweetmeats are called junket. The word is also used in a different sense, a junket being a spree or entertainment, while any form of jollification is called junketing. [J. GI.]

Jurassic.—This system of strata, coming between the Triassic and the Cretaceous, was at one time divided by British geologists into two, the *Liassic* and the *Oolitic* systems; but these may now be united, in agreement with

Continental classification, the Liassic beds corresponding to the Lower Jurassic series. Owing to the frequent changes in the character of the beds as we trace them upwards or even laterally, and to the excellent preservation of their fossils, the Jurassic system in England has become greatly subdivided; and it was among strata of this age near Bath that William Smith, about 1790, discovered the key to stratigraphical geology.

The typical succession in southern England is as follows:—

Series.	Stages.	Beds.
Upper Jurassic.	Purbeck and Portland stage.	Purbeck beds. Portland Stone. Portland Sand.
	Kimmeridgian.	Kimmeridge Clay.
	Corallian.	Coralline Oolite and Calcareous Grit.
	Oxfordian.	Oxford Clay. Kellaways Rock.
Middle Jurassic.	Bathonian.	Cornbrash. Great Oolite (Bath Stone), with Forest Marble and Bradford Clay.
	Bajocian.	Inferior Oolite. Midford Sands.
Lower Jurassic.	Upper Lias. Middle Lias. Lower Lias.	

Some beds of local importance are here omitted, and many of the divisions change markedly in character as they are followed across the country. Owing to the general tilt of the beds down to the south-east and east, the Jurassic strata appear as a broad band across England from Dorsetshire to north-east Yorkshire, forming scarps that face north-west or west, and long slopes dropping south-eastward or eastward. The Lias is easily denuded, being largely clayey, and it thus produces a lowland, though its higher strata form part of the scarps wherever they are protected by a cap of the Inferior Oolite. Limestones with oolitic structure are frequent in the Middle and Upper Jurassic series, whence the old name for this portion of the system; but large areas of clay occur where the Oxford and Kimmeridge beds appear on the dip-slopes. These clays have also furnished much material to the boulder clays of glacial age that overlie them and that stretch south as far as London.

Where the limestones prevail, a striking scarp appears, scarred by abundant yellow quarries, facing down on the Lias plain. Near Gloucester this forms the true Cotteswold or Cotswold Hills, and this feature is traceable through the milder country of Northampton to the conspicuous westward-facing ridge on which the towers of Lincoln stand. Similar beds form the uplands between the broad alluvial Vale of York and Whitby. Few scenes afford a finer contrast than those viewed from the edge of the Cotswolds, when, after the long rise of twenty miles or so from the east, one looks down suddenly into the Liassic and Triassic ground below. Outlying blocks of Upper Lias, capped by Middle Jurassic strata, such as the fine mass of Bredon on the Worcestershire border, rise like islands from the plain, and show how the great scarp has been cut back by denudation. The immense extent of Jurassic strata that has disappeared is proved by a patch of Lias remaining on the Shropshire and Cheshire borders, between Wem and Audlem, some seventy miles from the main outcrop. The Lias of north-east Ireland, moreover, was very probably once continuous with that of the English area.

The *Lower Lias* consists of well-stratified clays and shales, with bands of clayey and sometimes nodular limestone. In the south-western area, the famous 'blue Lias' limestone is largely quarried as a building stone, and also for cement manufacture. The *Middle Lias* or 'Marlstone' includes clays, clayey and ferruginous limestones, and sands, and the limestones in some places have been converted by chemical change into massive iron carbonate. The ironstone worked in the Cleveland Hills is of this nature. The beds of the Middle Lias weather typically to a rusty-brown colour. The *Upper Lias* is more generally clayey than the earlier strata, though still including some bluish limestone. The *Midford Sands* above it form a connecting link between the Lower and Middle Jurassic series, their fossils including species found in both series. The *Inferior Oolite* is a yellowish limestone, often slightly ferruginous, and not so eminently suitable as a building stone as some of the higher oolites. Its name, however, merely refers to its position in the sequence. The old manor houses and farm dwellings, with picturesque gables and chimney-stacks, that abound on both sides of the Cotteswold scarp are largely built of Inferior Oolite. On the dip-slope of the hills, the rock appears in numerous shallow quarries, capped by a thin stony soil. Though the first plateau seems bare and wind-swept, the stream-hollows cut into it down the dip-slope protect pleasant woods, and the country improves quickly as we descend to the south-east. In doing so, we cross successively the outcrops of higher and higher strata. The *Fuller's Earth* is a local bed, sometimes as much as 400 ft. thick, traceable from the Oxford border through Gloucestershire, and rich in layers of the peculiar absorbent clay used in fulling. The *Great Oolite* proper is equivalent to the 'Bath stone', an easily worked and massive oolitic limestone specially quarried near Bath for building. The *Stonesfield Slate* is not a true slate, but a well-bedded limestone that can be split into flags or slabs for roofing. It has been widely used in the Cotteswold area, where it is a local formation at the top of the Bath Oolite. The *Forest Marble*, another local formation in the same region, and named from Wychwood Forest near Burford, is a flaggy limestone, over 400 ft. thick in Dorsetshire, but thinning northward. It includes at its base the *Bradford Clay*, a band some 10 ft. thick. The uppermost strata of the Middle Jurassic are known by the old name *Cornbrash*, given them by William Smith; the term 'brashy' is still applied by agriculturists to stony soils. The Cornbrash is traceable as a limestone, often ferruginous, from Dorsetshire into Lincolnshire and Yorkshire.

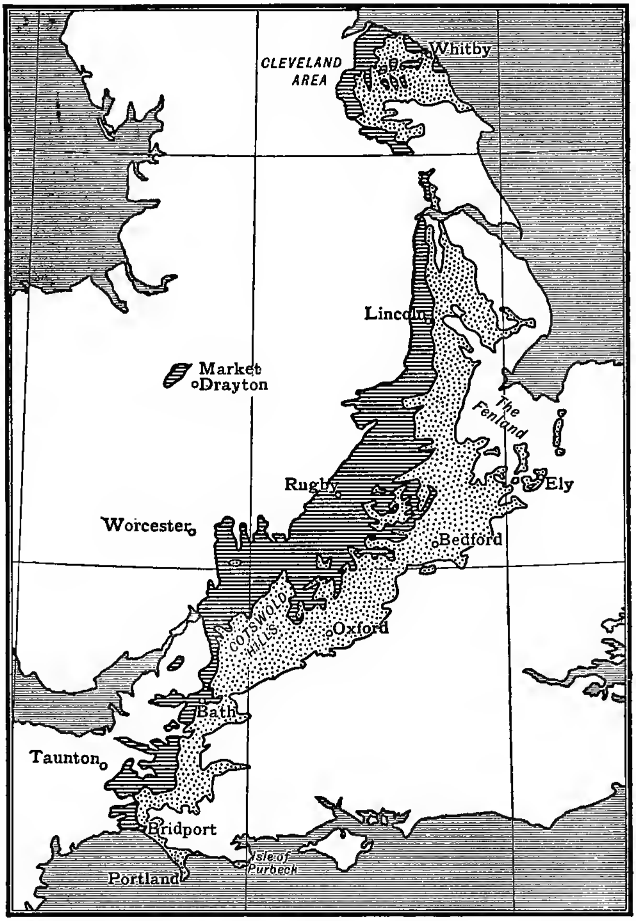
The Upper Jurassic series opens in the south-west with the sandy strata known as the *Kellaways Rock*, above which follow 300 to 600 ft. of *Oxford Clay*. This is mainly a stiff blue clay,

forming fairly level land; in some places, such as the Fenland and Lincolnshire, it is continuous with the blacker and equally stiff *Kimmeridge Clay* above it. In Yorkshire, however, the mass of the *Calcareous Grit Series* (see art. on this) intervenes, and this is paralleled by a similar series of limestones, with abundant corals, in the centre and south of England. The typical *Coral Rag* or *Coralline Oolite* occurs in Yorkshire between beds styled Calcareous Grit; it reappears between the Oxford and Kimmeridge Clays in Oxfordshire, and extends down to Weymouth. Where this limestone series is absent, parts of the clay beds probably represent it. The *Portland Beds*, including the famous 'Portland stone', an oolite of fine and even texture, do not extend north of Buckinghamshire, and the succeeding fresh-water and estuarine *Purbeck Beds* are also limited, preparing the way in Dorset, Sussex, and Oxfordshire for the fresh-water Wealden strata. An uplift of much of the Jurassic marine area occurred in Britain before the Cretaceous period opened, and fossils washed out of Jurassic rocks are frequent in the Lower Greensand. The Bathonian series in Yorkshire includes a good deal of estuarine sandstone, and oscillations of the sea floor were thus responsible for the deposition of a considerable variety of strata simultaneously within our limited area during Jurassic times.

The Jurassic sea entered Ireland, and Lower Liassic shales occur in the counties of Antrim and Londonderry, causing landslips where water flows between them and the masses of chalk and basalt resting on them. But this is a phenomenon of the coast line, and the beds play no part in the interior. Except for a few fossils found in the drift, washed from higher Liassic strata, the Irish Jurassic deposits are limited to the Lower Lias. In Scotland, however, representatives of the Jurassic system, certainly up to the Kimmeridge Clay, occur in an attenuated form round Brora in eastern Sutherland, and in Skye and other islands of the Inner Hebrides. Sandstones and shales of estuarine origin frequently occur in place of the marine limestones of England, and a bed of coal, formed of plants washed from the adjacent land, has been worked in the Bathonian of Brora.

[G. A. J. C.]

Jurassic Soils.—Many soils of the Jurassic system are exceptionally favourable for agricultural pursuits of one kind or another. The Lias pastures, for example, are the basis of the great dairying districts from which London draws a large proportion of its milk supplies, the thinner Oolite lands are favourable for the production of mutton, while the soils of the Cornbrash, as the name implies, are well adapted for the growth of cereals.



Sketch map showing area occupied by Jurassic strata in England. Lower Jurassic (Liassic) shaded heavy; Middle and Upper Jurassic (Oolitic) dotted.

Generally speaking, the soils of the *Lias* may be described as retentive clays, often wet and cold, but at the same time frequently supporting pastures of excellent quality. They are, as a rule, unsuited for arable culture, although when drained the stiffest of them may sometimes produce remunerative crops of cereals, beans, and clover. On these stiff soils the system of bare fallowing once in a rotation was formerly the custom; but now, as the land is being drained, the practice is no longer found necessary. The Lias clays are impervious to water, so that when they underlie the more open Oolite beds, they throw out a series of springs at the junction of the outcrops of the two formations.

On both the Upper and Lower Lias are to be found very rich pastures, some of which make excellent fattening land. The Vales of Gloucester, Evesham, and Berkeley are of this type, and fairly good dairying pastures exist on these formations in the counties of Somerset, Gloucester, Warwick, and Leicester. Stilton cheese is made on the Lias clays near Melton Mowbray in the last-mentioned county, while the double Gloucester cheese originated in the Vales of Gloucester and Berkeley. The Upper Lias soils, which are less extensive than those of the lower members, stand in much greater need of drainage; otherwise their characters are pretty similar. Bricks, tiles, and drain pipes are largely manufactured from the Upper Lias clays. Owing to the calcareous sandstone deposits which prevail in the Middle Lias or Marlstone, the soils on this formation are far less tenacious than the other Liassic soils, and are consequently largely under cultivation. They are usually rich loams like the red soils of Leicester, or the Rutland soils of the same geological horizon. Turnips, wheat, barley, clover, and lucerne are the principal crops they produce, but apples are sometimes grown, and excellent cider orchards may be found on this formation, as in the neighbourhood of Sparkford in Somerset.

The deposits which constitute the remaining members of the Jurassic system consist of clays, limestones, and sandstones, producing soils of great variety. Immediately above the Lias occur the *Midford Sands*, which contrast with the former deposits in yielding soils of a much lighter type, as in the counties of Dorset, Somerset, and Gloucester. They are fairly fertile, and are mostly under arable cultivation, although sometimes, as at Glastonbury Tor and Brent Knoll, they form grazing lands which are devoted to dairying.

The *Inferior Oolite* usually forms high ground, and yields a light brashy soil, often very poor and incoherent. Its pastures make typical sheep land, while roots, corn, clover, and sainfoin are grown on its cultivated areas. On account of its elevation, the harvest on this formation is generally about a fortnight late. The Northampton Sands, of the same age as the Inferior Oolite, and occurring in the counties of Northampton, Lincoln, and Rutland, produce light red soils well adapted to spring crops (Jerome Harrison, Geology of the Counties of England and Wales, p. 167).

The soils of the *Fuller's Earth* deposits have only a local interest, as they are practically confined to the counties of Dorset and Gloucester. They are generally heavy, wet grazing lands of a not very fertile description. Rich stony loams are the types derived from the *Stonesfield Flags*, which outcrop in the valley sides of certain districts of Oxford and Gloucester. These soils are particularly rich in phosphates, and their pastures abound in clovers and other leguminous plants (M'Connell, Agricultural Geology, p. 198). On the *Great Oolite* the soils are thin, dry, stony loams, the stones consisting of the shelly limestone fragments of the originating rock. Turnips, barley, and sainfoin are the crops best suited to this land, which is, however, rather light for profitable cultivation. In the Wychwood Forest area of Oxfordshire the *Forest Marble* yields a heavy brown loam with angular fragments of limestone rock. It forms a soil favourable for the growth of the oak, elm, ash, and fruit trees. The Dorset representatives produce poor wet lands, which are allowed to remain in grass (Jerome Harrison, work quoted above, p. 74). Almost all the soils of the Forest Marble require artificial drainage. The *Cornbrash* soils are stiff clay loams with a high proportion of angular rock-fragments or 'brash', to which they owe much of their fertility. They form excellent corn lands, especially in the south of England. The rock is used for road metal and building material, and is sometimes burnt for lime (Woodward, Geology of England and Wales, 2nd ed., p. 308).

On the *Oxford Clay*, as may be seen for miles round the town of Oxford, the soils are tenacious retentive clays, difficult and expensive to cultivate. They are allowed to remain almost entirely in pasture, which is utilized for the feeding of milch cattle. The Stilton cheese of Huntingdonshire is produced on this formation. In Bedford, the Oxford Clay is often deeply covered with superficial deposits, a fact which prevents its exercising any great influence on the character of the soils. Since this clay underlies much of the fen country, it is extensively used for the amelioration of the fen soils. Tillage is practised only where the clay is modified by sandy or gravelly drifts, or where the detritus from the lower calcareous grits appears. There are no springs in the Oxford Clay, and to get water it is necessary to bore into the underlying Kellaways beds. The *Corallian* and *Coral Rag* furnish stony calcareous soils, as in the Wiltshire area, usually of a thin sandy nature, but frequently deep and loamy. The bulk of the land is under the plough, and sheep are folded on the turnips. The *Kimmeridge Clay* makes better land than the Oxford Clay, but like the latter it is allowed to remain in permanent pasture. A further point of resemblance between them is the absence of springs. Oaks, which are clay-loving trees, thrive particularly well on this formation.

The beds of the *Purbeck and Portland Stage* mostly yield poor, light calcareous sands not unlike those on the Coral Rag. [T. H.]

Justice of the Peace.—Justice of the Peace is a very ancient office. By 1 Edw. III, St. 2, c. 16 [1327], it was enacted that thenceforth in every county certain persons should be assigned by commission to keep the peace. By 34 Edw. III, c. 1 [1360], the persons so assigned acquired the title of Justices of the Peace.

At the present day, justices for counties are appointed by the Crown, usually on the recommendation of the Lord-Lieutenant of the county to the Lord Chancellor. There was formerly an estate qualification for county justices, but this has been abolished by the Justices of the Peace Act, 1906 (6 Edw. VII, c. 16). The same Act provides that a person may be appointed Justice of the Peace for any county notwithstanding that he does not reside in the county if he resides within seven miles thereof. Justices for boroughs having municipal corporations and

separate commissions of the peace are appointed by the Crown. The Lord Chancellor in some cases adopts the recommendation of the town council in this respect. The mayor is ex officio a justice during his year of office and the succeeding year. The chairman of a county council and the chairman of an urban or rural district council, unless a woman or personally disqualified, are ex-officio justices for the county during their term of office. Before acting, justices must take the oath of allegiance and the judicial oath as prescribed by the Promissory Oaths Act, 1868. A record is kept at the Crown Office of the appointment of Justices of the Peace. The fees recommended by the Home Office in July, 1894, for adoption by standing joint committees of counties in the table of Clerk of the Peace fees on qualification of county justices are as follows: 'Fee to be paid by county justices, other than justices ex officio under any Act of Parliament, on qualifying as such to include oaths, Crown Office fee, correspondence, and every other expense connected therewith, £2. Fee to be paid on administering oath of office to justice ex officio under any Act of Parliament on qualifying as such and to all other persons, 5*s*.' (see 58 J.P. 546).

A person who is adjudged bankrupt is disqualified from being appointed or acting as Justice of the Peace, but the disqualification will be removed and cease if the adjudication is annulled, or he obtains from the Court his discharge with a certificate that the bankruptcy was caused by misfortune without any misconduct on his part (Bankruptcy Act, 1883, s. 32). The disqualification will not exceed a period of five years from the date of any discharge (Bankruptcy Act, 1890, s. 9).

Justices have only power to execute judicial acts within their county or borough, but merely ministerial acts may be performed out of the county, such as the taking of declarations. County justices may, generally speaking, exercise the duties of their office in any part of the county on the commission of which they are placed, and are not confined to the petty sessional divisions in which they reside.

The duties and powers of Justices of the Peace are very numerous, and it is impossible to enumerate them here. They include powers under the Summary Jurisdiction Acts to hear and determine informations dealing with petty offences and complaints in various civil matters the decision of which has been committed to them. They also have various administrative powers, such as granting licences for the sale of intoxicating liquors, hold-overs, and transfers of public-houses, &c. (see Stone's Justice of the Peace). Their powers include the hearing of informations in respect of indictable offences under the Indictable Offences Act, 1848, the issuing of warrants or summonses, and the committing of the accused person for trial at the Quarter Sessions or Assizes either in custody or on bail. Justices of the Peace also form the Court of Quarter Sessions for their county or borough. In County Quarter Sessions a chairman appointed by justices presides, and gives the judgment of the Court. In Borough Sessions the recorder or his duly appointed deputy is the sole judge. [A. J. S.]

Jute is the bast fibre obtained from two species of Jew's Mallow, viz. *Corchorus capsularis* and *C. olitorius* of the Tiliaceæ (the Lime or Linden family). The former is the cultivated jute plant of Eastern and Northern Bengal, of Assam and of China (more especially of Canton and Ningpo), while the latter (the least important source of the fibre of commerce) is indigenous to the rest of India, and cultivated only in Bardwan, Khulna, 24-Parganas, and Hughli. *C. capsularis* is the jute plant

Jute (*Corchorus capsularis*)

1. Flower. 2. Fruit.

of inundation lands, while *C. olitorius* is that of high and dry soils. Jute is most productive when sown on loamy soils or rich clays, with a fair admixture of sand. On situations subject to inundation, ploughing commences earlier than on the higher lands. Preparation for the crop thus is made in November or December, or not till February or even March, and accordingly the sowings extend from March to June. Harvest commences about June for the early crop, and extends to October for the late, the chief harvest being from the middle of August to the end of September.

The process of separation and cleaning of the fibre may be described as one of simple and inexpensive *retting*. The stems are cut close to the ground, tied into bundles, and placed in stagnant sweet water, and kept below the surface till decomposition of the connecting tissue has been effected and the fibres thus liberated. The ribbons of fibrous bast are then stripped off from the canes and violently beaten on the surface of the water till freed from all adhering

tissue. The water is then wrung out, and the clean fibre exposed on racks to the sun and air to be both bleached and dried. The fibre is then conveyed to local centres, where it is graded, packed, and pressed ready for export. The cleaning of the fibre thus necessitates no special machinery, nor any more expert knowledge than can be given by the ordinary cultivator.

In 1872 it was estimated that there were one million acres under jute in Bengal, distributed over an area of 37 million acres of land suitable for that crop. In 1902 jute occupied two million acres, while the cultivated area of the region of production was returned as 60 million, with in addition 14 million acres of cultivatable waste. In 1903–4 the jute area was 2,275,050 ac., or 3½ per cent of the cultivated area, with a yield of 7,241,000 bales (each of 400 lb.). In 1905–6 there were 3,181,600 ac. under the crop in the two Bengals and Assam, with a production of 8,384,000 bales. Owing to low prices subsequently the acreage was decreased slightly, so that in 1908 the estimate for Eastern Bengal and Assam came to 2,263,000 ac., and for Bengal proper 574,300 ac. The average crop is perhaps only a little over 12 maunds (of 82 lb.) per acre, while the range may be said to be from 36 to 6 maunds. It has been estimated that with high-class cultivation, costing even as much as Rs30, the net profit should be from Rs20 to Rs30 an acre according to prices ruling. Jute can thus be produced at an average of Rs2 a maund, and with freight and agency charges can be landed at Calcutta at Rs3 a maund or Rs82 a ton (or say at £5, 10*s.* a ton overhead, or for the first marks say at £7, 10*s.* a ton f.o.b.). The London quotations are, for 'good white' to 'best', £27 to £34; for 'common', £15 to £17; for 'rejections', £10 to £13; and for 'cuttings', £6 to £8 a ton. In view of these somewhat startling particulars of the trade it has recently been urged that jute might easily, and with advantage to the commerce of India, bear an export duty. Another very startling circumstance may be said to be that, in consequence of the cheapness of the fibre, the jute mills of Bengal have been able to offer such high wages to their employees as to do a positive injury to other branches of manufacturing enterprise. There are, in fact, many aspects of the jute trade of India that are exceedingly interesting, but none more so than that, in spite of all efforts at participation, a practical monopoly in production remains with Eastern Bengal. Outside India the only dangerous rival may be looked for in China, which very possibly was the original region of production.

Jute manufacture was first experimented with by Europeans in 1820; in 1828 the exports of the fibre to Dundee came to 364 cwt., and from that date gradually, to both Dundee in manufacturing and Bengal in growing the fibre, new industries were given. It was not until 1854 that an effort was made to organize jute mills in India itself. Ten years later the banks of the Hughli river both above and below Calcutta began to bristle with mills. In 1891–2 there were twenty-six such mills, with a capital of Rs1,37,50,000 Indian, plus £1,757,000 British capital. In 1906–7 there were forty-four mills, with a capital of Rs5,41,80,000, plus £2,718,358. These gave employment to 166,895 persons engaged on 25,284 looms and 520,504 spindles. The growth of Indian capital is thus another surprising feature of this new industry. The Indian mills use up a little more than one-half the jute produced annually, but for some years their share has been increasing at the expense of the foreign. And this may be said to be a natural expression of the fact that the number of looms and spindles in use, as also the production of the mills, have been for years steadily increasing at a higher ratio than either the number of the mills or the capital invested in these. Hence it may be said that if the ratio of values returned for the manufactures exported be accepted as applicable to those used up in the country, we learn that a value of say 22 million pounds sterling would not overstate this contribution of European enterprise paid annually to the agriculturists and traders of Bengal. The production of jute—the cheapest of all known commercial fibres—has thus become to Bengal, after rice, the most valuable single crop that that province possesses, and yet sixty years ago it can hardly be said to have existed. [G. W.]

K

Kade. — The kade, or as it is more frequently termed, the 'ked', which causes so much annoyance to sheep, and especially to lambs, is described under the heading MELOPHAGUS.

Kaffir Corn, Guinea Corn, Turkish Millet, Indian or Great Millet, Broom Corn, Sorgho, Imphee, &c., are some of the more generally used European names for *Sorghum vulgare*, Pers. (*Andropogon Sorghum*, Brot.), ord. Gramineæ or Grasses. In Africa and Egypt this is known as *dúra* (variously written *dhúrra*, *dhaura*, *douro*, &c.), and in India as *juár*; but these vernacular names were doubtless derived from the ancient Sanskrit *yava-parkára* or *akára*, passing into *yávanála*, *jávanála*, *jauanára*, *juár* (Indian), and finally *zúra*, *dúra*, &c. (African). This more or less Indian history is of interest in the light of the origin of the cultivated plant, and of the climatic and soil conditions under which it is most successfully produced.

All the cultivated forms seem to have been derived from *Sorghum halepense*, Pers. (the Cuba or Johnson Grass), a wild perennial plant common throughout India, Burma, Ceylon, and certain other warm countries. According to some writers the cultivation of Kaffir corn originated in Africa (not India), and in fact reached Asia by sea. But if that view be

upheld we would be justified in looking for its present-day Indian cultivation as centring within the coast lands, and in seeking for its earliest records in association with the various peoples of that tract of country. The reverse, however, is the actual case. Sorghum cultivation in India is, and has always been, closely connected with the drier upland interior regions, with the very country where the presumed wild stock is especially plentiful. In most countries, in fact, Kaffir corn is grown between latitudes 45° N. and 35° S.—in other words the cotton area. But both in India and Africa it is most abundant and of the greatest value on the upland

Kaffir Corn or Millet (*Sorghum vulgare*)

tracts lying between 15° and 30° N. and S. In the warm, moist regions nearer the Equator (as also lower down country nearer the sea) it hardly ranks as an important cereal. The great merit of this particular millet is its power of giving good crops in hot arid regions. It prefers a dry climate, and one where the temperature rarely falls below 60° F. In southern Europe (Spain and Italy), in Syria, North Africa, the Soudan, and the great central tableland of India, it becomes accordingly one of the chief cereals, taking the place of oats, barley, and wheat of the more northern cultivation, and of rice in the moister and warmer tracts to the south.

The cultivated forms may be grouped into two chief assemblages. These are in India spoken of as the *Kharif* (Autumn) or rainy-season—the early races, and the *Rabí* (Spring), or late series. The latter are those that approximate most closely to the type of *S. halepense.* The autumn forms have compact heads, more or less rounded grains, and the floral envelopes (chaff) are almost completely glabrous. To contrast with these characteristics it may be added that the spring races have lax feathery panicles, elongated grains, and the floral envelopes are more or less hairy, while the stems are often highly charged with a sweet sap or sugar. As a rule the finer grades have the grain creamy-white, the extremity only being dark coloured. It is customary also for the grain to be slightly flattened near the apex, and often to become almost hooked or even indented. Curved grains are generally the most highly prized for the purpose of being parched. In some forms the envelopes are coloured and the grain white, while in others the inner (or seed) coat is also tinted. Lastly, the floral envelopes may firmly embrace if not unite to the grain, while in others the attachment may be so slight that the grain may deserve the description of being naked (as in some barleys). In India *juár* becomes important on the upland black or mixed black soils, where the rainfall is moderate and evenly distributed; when excessive rainfall prevails, guinea corn gives place to rice, and on sandy loams and shallow soils to another millet, the *bajra* (*Pennisetum typhoideum*). An interesting feature, and one that probably denotes antiquity of cultivation, is that the early and late crops are not interchangeable either in season or in soil. It is not therefore enough to procure seed of any Kaffir corn in order to ensure production; it is indispensable to obtain a supply of the particular kind suited to the climate and soil of the region of contemplated production.

After the land has been prepared so as to bring it into a good tilth, the seed is sown for the *kharif* crop about June, the amount required being from 6 to 8 lb. to the acre. In India it is customary to pursue a system of mixed cultivation, the *juár* seed being mixed with from 1 to 2 lb. of some pulse. That mixture is drill-sown, the lines being 14 in. to 2 ft. apart, and the plot hand-weeded and thinned out, so that the seedlings may not be nearer each other than 1 ft. on the lines. The *juár* will come into flower in August or September, and the crop be ready for harvest in October to November. The system varies slightly, being often broadcasted and thinned out when the plants come above-ground. The later (*rabí*) crop is sown in September to November, and reaped in February to April. It has been said that in India 500 lb. of grain to the acre would be a safe average estimate, erring on the side of under- rather than over-stating production. To the Indian area known to be annually devoted to the crop this would amount to say 5 million tons of food produced a year. Other estimates speak of 900 lb. of grain to the acre, and ten times that quantity of fuel and fodder. It has thus to be borne in mind that *juár* is not alone of value as human food. Its stems constitute the chief cattle fodder of the regions where it is grown to any material extent. Indeed here and there special races are raised exclusively as green fodders. In fact, no other plant can compare with Sorghum in the yield of green fodder

of a rich quality. That statement would, in fact, place it amongst the most desirable of all fodders but for the qualification that it is necessary to here make, namely, that under certain conditions it has proved poisonous. The young plant has frequently been found dangerous in Egypt, the West Indies, the United States of America, and in India. It has been found that, when ground up along with water, prussic acid has originated, due to the interaction of a crystalline glucoside called *dhurrin* and an unorganized ferment known as *emulsin*, both of which occur in the plant. Under certain climatic conditions and in special forms these are found to such an extent as to prove positively dangerous.

Much has been said regarding the value of another group of forms of Sorghum as sources of sugar. These have been specially studied in the United States. Two of the chief forms of this series are known as the amber and the collier. The weight of molasses to the acre produced has been stated as 1174 lb. for the collier and 1072 lb. for the amber.

It is impossible to give any sort of conception of the world's production of this cereal. In the official returns of the trade of the United Kingdom the imports of *dari* or *durra* (presumably Kaffir corn) in 1907 were 501,846 cwt., valued at £132,845. That supply came in almost equal quantity from Turkey in Asia and from the British possessions. The exports of *juár* from India do not exceed 1 per cent of the production, so that after rice it is the most important single article of human food produced in that country—and this is true of a very large portion of the drier tracts of all tropical countries. For further information see MILLETS, also SORGHUM. [G. W.]

Kainite, which is also commonly spelt in the German fashion kainit, is the name given to certain crude salts containing potash which are obtained from the German potash deposits and very extensively used as manure (see POTASH MANURES). The mineral kainite is a double salt of potassium and magnesium, $KCl,MgSO_4 \cdot 3H_2O$, which, if pure, would contain potassium equal to nearly 19 per cent of potash. Ordinary commercial kainite, however, is by no means composed of the pure mineral kainite. It always contains a considerable amount of common salt, sodium chloride, and smaller amounts of other impurities. The potash in ordinary commercial kainite is about 12·4 per cent. The mineral kainite is found in immense quantities in the German salt deposits, from which practically the whole of the world's supply of potash manures is obtained. The raw salts are brought to the surface, ground, and graded so as to contain about 12·4 per cent of potash, and sent out into commerce. It is commonly stated that kainite contains its potash in the form of sulphate of potash. This does not appear to be the case. Most of the potash is present as chloride (muriate of potash). In any case the point is not one of any great practical importance, for commercial kainite always contains a great amount of chloride in the form of common salt, and its effect upon crops is not the same as that of a real sulphate of potash. Ordinary commercial kainite contains about 35 per cent of common salt, about 30 per cent of magnesium salts—chiefly magnesium sulphate, and about 12·5 per cent of water of crystallization. The remainder is made up almost entirely of potassium salts, though small quantities of impurities are present. It will thus be evident that of every 3 cwt. of kainite quite 1 cwt. consists of common salt and nearly 1 cwt. of magnesium salts. Less than 1 cwt. out of every 4 consists of pure potassium salts. The potash in commercial kainite is generally between 12 and 13 per cent. The standard amount is 12·4 per cent. Along with kainite are classed Hartsalz and Schoenite, other impure potassium salts which contain magnesium salts and common salt. These are not as a rule sold separately, but form constituents of commercial kainite.

The output of commercial kainite has increased very rapidly during the past thirty years. The following table gives the quantities in metric tons of kainite, including Hartsalz and Schoenite, produced in different years:—

1865	... ...	1,314 metric tons.
1870	... ...	20,301 ,,
1880	... ...	139,491 ,,
1890	... ...	401,871 ,,
1900	... ...	1,189,394 ,,
1905	... ...	2,405,536 ,,

No other crude potash salt is produced in such quantities except carnallite.

Kainite may be of various colours. If pure it is colourless, but it is usually found tinted various colours, such as red, yellow, grey, and black, owing to the presence of small quantities of coloured impurities. The commonest colour of the commercial article is a pale-pink. Farmers are sometimes alarmed when they get a sample of unusual colour, and think there is something wrong. Kainite may exhibit a wide range of colours, from very dark to almost pure-white, and still be of quite good quality.

As a potash manure, the use of kainite is affected by the large quantity of sodium and magnesium salts which it contains. It is best not to apply it directly in the drills for such crops as turnips and potatoes. It is found that the large amount of impurities which it contains injuriously affects the quality of potatoes, and may injuriously affect the young turnip plant. There is also some evidence to show that it should not be spread upon young clover plants in spring when they are just starting growth. When kainite is used upon these crops, it should be spread in winter. As it is soluble, it is soon washed into the soil, where the potash is fixed, while the injurious constituents are washed into the drains by the winter rains, or so distributed and modified in the soil as to be rendered harmless.

On the other hand, kainite is a most suitable potash manure for use for such crops as mangels and corn crops, to which common salt is frequently applied. Instead of using common salt, a dressing of kainite, which supplies a potash manuring as well as common salt, is now frequently given.

Kainite is the most generally used and popular of the potash manures. To some extent this is because it is the cheapest per ton. It is to be remembered, however, that though it is the cheapest per ton it is not usually the cheapest per unit of potash. One ton of standard muriate of potash containing 50 per cent. of potash (see MURIATE OF POTASH) is equal in potash to 4 tons of kainite; and 1 ton of 30-per-cent potash salt (see POTASH SALTS) is equal in potash to 2½ tons of kainite. As kainite is an unmanufactured salt it is cheaper at the place of production than a manufactured salt like muriate of potash. But the farther from the point of production the dearer in proportion becomes kainite as a source of potash, for 4 tons of kainite have to be carried to supply the same amount of potash as 1 ton of muriate of potash. Therefore when kainite is used merely as a potash manure, and the salt which it contains has no value, it is not the cheapest source of potash. [J. H.]

Kale, a synonym for borecole. See BORECOLE.

Kames, Lord. — Henry Home, better known as Lord Kames, was born at Kames, in Berwickshire, in 1696. An eminent Scottish judge, he was the son of a country gentleman, and for many years farmed his own estate. As an amateur agriculturist he acquired considerable reputation in the border districts, and at Blair Drummond, near Stirling, where he afterwards removed, he carried out with notable success extensive experiments in the improvement of moss land. In 1776 he published his best-known work, The Gentleman Farmer, a valuable contribution to the agricultural literature of the day. An essay on Observations on Shallow Ploughing, The Farmers' Magazine, and a report on the Progress of Flax Growing in Scotland are among the better known of his works on rural subjects. He died in 1782.

[R. H. L.]

Kangaroos belong to the group of mammals known zoologically as marsupials, in which the young is never connected with its mother by means of the vascular tissue called the placenta, but is born at an extremely early stage of development and is transferred by its parent to an abdominal integumental pouch, where it hangs suspended to one of the teats. In this order, the Marsupialia, which contains a vast majority of the indigenous Australian mammals, the kangaroos constitute the family Macropodidæ, which is essentially characterized by the structure of the hind feet. These limbs are large and four-toed, the first toe of the normal five-toed foot being absent, the second and third very slender and short and united in a common sheath of skin, the fourth toe enormously large, and the fifth of moderate size. The fore limbs are short and slender in comparison with the hind limbs, and the tail is long, thick, and very muscular. When moving quickly, kangaroos progress by means of a series of leaps in which the hind legs alone are employed; but when grazing or moving slowly from place to place, both front and hind legs and the tail are used, the tail acting as a prop to the hind quarters when the hind legs are raised from the ground and moved forwards. On account of the speed with which they can cover the ground, and the determined manner in which they defend themselves by kicking when brought to bay, the larger kangaroos make excellent sport, powerful dogs of the greyhound or staghound type being required to catch and pull them down. They readily take to the water when pursued, and are strong swimmers. Although born in the summer, the young do not venture to leave the mother's pouch until about two months old. They are then able to feed by the mother's side, but for a few weeks they habitually take refuge in her pouch when danger threatens, until increase in size makes this impossible. All kangaroos are vegetable feeders, and subsist to a great extent upon grass and herbage of various kinds. The best-known species are the following: The Great Grey Kangaroo (*Macropus giganteus*), the 'old man' of the early colonists and the 'koora' of the aborigines of Australia, is widely distributed over all the southern parts of the continent, and occurs also in Tasmania. The general colour of both male and female is grey or greyish-brown, but local varieties occur, like the sooty kangaroo (*fuliginosus*) of Tasmania, and the black-faced kangaroo (*melanops*) of Eastern Australia. This species frequents open country overgrown with scrub and intersected with ravines, in which it takes refuge during the heat of the summer's day. It was formerly very abundant, occurring in herds or 'mobs' of about one hundred individuals; but owing to the damage it did to pasture land that was required for cattle and sheep, it was mercilessly slaughtered by the early settlers, and its numbers were greatly diminished. The skin of this and other species makes excellent leather; and large bales of hides are annually exported from Australia for this purpose.

The Red Kangaroo (*Macropus rufus*), if anything, exceeds the Great Grey Kangaroo in size. The coat, however, is more woolly, and the nose is naked instead of being hairy. The male of the typical race from Eastern Australia is red in colour, but the female is pale slaty-grey. In parts of Western Australia, however, the females are red like the males. Although sometimes found in the same situation as the Great Kangaroo, the Red Kangaroo seems to prefer more open and rocky country.

The Wallaroo (*Macropus robustus*) is a smaller species than either of the preceding, and has the fore limbs much shorter and the coat hairier. It occurs in mountainous and rocky situations of both Eastern and Western Australia. In the eastern form, the typical Wallaroo, the adult male is nearly black and the female grey; but in the western races, named *isabellinus*, *cervinus*, and *woodwardi*, both sexes are yellowish-red in hue.

The three species of kangaroo here described are hardy animals, and thrive well in parks in England despite the cold of winter. [R. I. P.]

Kaolin, or **Kaolinite.** — This mineral is the basis of many of the rocks called Clays, and commonly occurs in very minute platy particles, visible as individuals only with a microscope. It is a silicate of aluminium combined with water ($H_4Al_2Si_2O_9$), containing 46·5 per cent of

silica and 39·5 of alumina. It is a product of the alteration of other aluminous silicates, notably of felspars, and is insoluble in hydrochloric acid, and only slowly soluble in hot sulphuric acid. It arises wherever granitic rocks are exposed to the continued action of natural acids, such as carbonic acid, on the surface of the earth; but large masses of kaolin do not accumulate unless the decomposition of the rock goes on underground, through the prolonged attack of acid vapours. Great 'pockets' of altered rock occurring in this way may be profitably mined, as at St. Austell in Cornwall, the kaolin being artificially washed out of them as *China clay.* Natural agents in the past have accumulated kaolin, together with sand, to form common clays (see art. CLAY), the extreme fineness of the mineral in part being responsible for the plastic character of the mass. [G. A. J. C.]

Katabolism, the disintegration or destructive changes taking place within the protoplasm of the cell. See METABOLISM.

Ked, the common name for the sheep tick. See MELOPHAGUS.

Keel-marking. See art. MARKING SHEEP AND CATTLE.

Kelp is the ash of burnt seaweed. At one time it was of considerable importance as supplying the raw material for certain industries. Within recent years, however, cheaper sources of supply of this same raw material have arisen, the effect of which has been to injure very materially the once very profitable kelp industry. Notwithstanding this competition the industry is still carried on with remuneration and benefit to the crofters and cotters in the western islands of Scotland. The constituents of the kelp which are of commercial value are the salts of iodine, potash, and soda. Courtois, a Parisian saltpetre maker, and the discoverer of iodine, first obtained this element from kelp, and as a source of iodine, kelp and its manufacture assumed considerable importance in those areas where seaweed was obtainable. Dr. Ure of Glasgow was the pioneer of the iodine industry, using kelp as the raw material. His works, close to Glasgow, with only a few others, still form the principal manufacturing sources of iodine in Great Britain at the present day. However, the iodine of commerce is now mostly imported from Chile, where it is obtained from *caliche*, the crude product from which nitrate of soda is obtained. Besides iodine, kelp was practically the principal source of the potash and soda salts in the early days of the soap and glass industries. Owing, however, to the discovery of enormous deposits of potash and soda salts in Germany, around the town of Stassfurt, and to the invention of methods of manufacturing the carbonate from the salts obtained, the kelp industry received a severe blow—in fact the new and cheaper sources of alkali salts have largely superseded the old kelp supply.

The Western Hebrides and other islands on the west coast of Scotland form one of the principal sources of kelp. When the industry was at its zenith it formed a great source of wealth to the lairds and a profitable industry for the crofters and cotters in those islands, but as the industry declined the latter were the first to suffer. The composition of kelp varies according to the species of seaweed and to the care taken in its preparation. There are two types of seaweed used, namely, the drift-weeds, which consist of the two species *Laminaria digitata* or tangle, and *Laminaria stenophylla*; and the cut-weeds, which include principally *Fucus serratus* and *Ascophyllum nodosum.* The drift-weeds contain about ten times as much iodine as the cut-weeds. They flourish just below low-water mark. In stormy weather they become torn up from their rock moorings and cast on the shore. Abundance of this weed is thrown up on the coasts of Ayrshire during the long spells of prevailing south-westerly winds, having been detached from their moorings on the submerged rocks and reefs offshore. The cut-weeds grow on rocks close inshore, from which they are cut and gathered.

The following is an analysis of a sample of kelp:—

Potassium sulphate	13·95 per cent
" chloride	17·79 "
Sodium chloride	14·00 "
" carbonate	3·92 "
" thiosulphate	0·75 "
" iodide	0·76 "
Insoluble matter	44·80 "
Water	4·05 "
	100·02

In the carbonizing of the seaweed much of the iodine may be lost unless the temperature is carefully regulated. The ash or kelp should be of a powdery consistency when the weed has been suitably burnt. If, however, the temperature is uncontrolled or deliberately raised, as is often the case, the ash fuses into a hard slag, and in the process loses the greater part of the iodine and much of the potash. By burning the kelp to a hard slag the kelpers were under the misapprehension that they were obtaining a greater weight of kelp than if burnt to the powdery form. Shallow pits were at first used for the incineration of the dried seaweed. These were improved upon and superseded by the closed retorts introduced by Stanford, who first erected them on islands in the Outer Hebrides. The advantage of the retorts is that the volatile products evolved on heating the seaweed are collected. They consist of tar and ammoniacal liquor, which in the old process were lost. The kelp is left as a black porous mass containing all the iodine. From this porous charcoal the iodides and other valuable salts are dissolved out with water and obtained by evaporation. The charcoal left is an excellent deodorizer and decolorizer, and is employed largely in sewage filtration works, water closets, and as carbon, cement, &c. This process is in operation mostly in the islands of Tyree and North and South Uist, off the west of Scotland, where it still offers a remunerative occupation to the crofters and cotters. Stanford has made a further improvement on the carbonizing process, which consists of macerating the air-dried weed with carbonate of soda. This dissolves out the iodides along with the other useful salts, and the solu-

tion is then separated from the residues, called algulose. Hydrochloric acid is then added to the solution, which precipitates a compound called alginic acid. This is filtered off, and the filtrate containing all the iodine is evaporated, and the residue called 'kelp substitute' obtained.

The iodides from the kelp are dissolved out with water, and the solution obtained used for extracting iodine and other bodies of commercial value. Kelp will yield from 25 to 30 lb. iodine per ton. [R. A. B.]

Kennel. — Many people who devote a considerable amount of care to the comfort of their dogs, so far as the details of feeding are concerned, appear to be entirely indifferent to the necessity for providing their animals with proper accommodation. No doubt the hardier varieties are capable of roughing it in an improvised kennel made out of old boxes; but as damp and draughts are responsible for the majority of canine ills, such a shelter is wholly unadapted to the requirements of the more delicate breeds, or in fact for any dogs whose coats require attention. The worst design of kennel, and the most common of all, is the ordinary span-roofed box, with an unnecessarily large opening in front for the dog to go in and out by. This sort of kennel exposes its occupant to rain and cold, whilst if the animal is kept chained up (and no dog ever should be if it can possibly be avoided), the bedding is liable to get drawn out when he emerges from his place of shelter. Consequently, if a movable span-roof kennel is used, the opening should be at the side, close to the end, so that the dog can find shelter from the elements. The best of all kennels, however, are those designed by Spratt's Patent, which take the form of either span-roofed or lean-to sheds with runs attached. These runs can be made of any size as they are enclosed by iron hurdles, of any height that may be desired, and they possess the additional advantage of being capable of being covered in, so that their occupants are protected from rain or snow. If possible the shed in which a dog lives should always be provided with a wooden bench, raised a foot or so from the ground, for the animal to sleep upon; and if this bench, or shelf, is hinged so that it can be turned up against the wall, cleansing operations will be greatly facilitated. When the sheds are erected against a wall the latter ought to be lined with wood, as there is always a tendency on the part of brickwork to become damp, and if so there is a chance of the inmates of the shed contracting rheumatism or even more serious ailments. If the floor of the kennel is composed of asphalt or concrete—these are the two best materials, as bricks and boards are apt to absorb the moisture—it is most desirable that it should be covered with a layer of coarse sawdust or peat moss; and care should be taken to see that a ventilator which works properly is situated as high up on one side as possible; whilst if there is a small glazed window, also placed high up, it will be all the better. Finally, excepting in the case of the very small and delicate breeds, no artificial heating is necessary, provided that the dogs get a sufficiency of good straw to lie upon. [V. S.]

Kennel Lameness. — This old term is still applied to rheumatism in dogs, and may include a stiffness and unwillingness to leave the kennel, into which the dog entered apparently well the previous day; or it may mean acute rheumatic fever, or so-called chest founder. In either case the symptoms are those of pain and inability to move, loss of appetite, and a most dejected expression. Happily for dogs so subject to rheumatoid affections, the discovery of salicine has placed a remedy in our hands that may be almost called a specific, if employed early in the case. Dogs take from 5 to 20 gr. of salicylate of sodium, three times a day in the first instance, less often later in the case. See also RHEUMATISM. [H. L.]

Kent Sheep. See ROMNEY MARSH SHEEP.

Kentucky Blue Grass, the American name for Rough-stalked Meadow Grass (*Poa trivialis*). See BLUE GRASS and MEADOW GRASSES.

Kephir, a fermented milk used by the people of the Caucasus, and the product of a triple fermentation—lactic, alcoholic, and peptonizing; the kephir grains used as a 'starter' of the fermentation being apparently associate masses of bacteria and yeasts. Kephir or *kefir* is now used to a considerable extent in Germany, being recommended for certain classes of invalids. See KOUMISS.

Keratoma.—Horn tumours occur in horses' feet as the result of pressure of the toe clip or other injury, and, growing inwards, cause lameness which can only be dealt with by surgical operation—not always permanently successful. Horn tumours also occur upon the feet, skin, and even upon mucous membranes of other animals, dogs having them as outgrowths from the pads. Excision or rasping away, where practicable, is the treatment advised. In certain situations, where operation is not possible, they may be dissolved by repeated applications of a caustic alkali, as the solution of potash of the British Pharmacopœia. [H. L.]

Kernel is the term applied to any part of a plant enclosed within a husk or a shell. In the oat, for example, the grain or groat enclosed within the husk of pales is the oat kernel; and in the hazel nut, the seed within the shell or seedcase is the nut kernel. In both examples the kernel is the important part. In the oat it is used for meal making, and in the nut it is the edible part within the hard shell. [A. N. M'A.]

Kerosene.—Kerosene is the name given to certain mineral oils used for burning in lamps as illuminants. Mineral oils, commonly known as paraffin oils, are found widely distributed throughout the world. They are also manufactured by the distillation of certain shales. They consist almost entirely of hydrocarbons of various densities and boiling-points. Kerosene is largely derived from American mineral oil or petroleum. The crude petroleum is refined by treatment with sulphuric acid and caustic soda, and then fractionally distilled. The fraction which distils over between 150° and 300° C. forms the illuminating oil and is known as kerosene. It consists mainly of paraffins containing

from 10 to 16 carbon atoms in the molecule. It gives off vapour at temperatures much below its boiling-point, and if much vapour is given off this readily forms an explosive mixture with air. It is unsafe, therefore, to use oils of low boiling-point. Also, if kerosene is allowed to become much heated it is unsafe, as it then gives off inflammable vapour freely. [J. H.]

Kerria, a genus of deciduous slender-branched shrubs (nat. ord. Rosaceæ), formerly known as Corchorus. *K. japonica*, which has yellow flowers borne in spring, is the only species cultivated, and then usually in its more vigorous double-flowered form. It is well adapted for growing over a porch or arbour, and there is a variety with silver variegated leaves. It thrives in any moderately good soil, and is readily propagated by division or by cuttings of the young shoots. The single-flowered form should not be neglected, as it is of good appearance and has the merit of being often in flower. [W. W.]

Kerry Cattle. See IRISH CATTLE.

Kerry Hill Sheep.—This breed, which is now officially described as the Kerry Hill (Wales) breed, is, as its name indicates, a native of the Principality, and takes its name from the range of hills that extends for several miles through the ancient parish of Kerry in Montgomeryshire. In its present form it is a comparatively new breed, but one which possesses merits that have earned for it an enduring reputation far beyond the limits of its native district. Kerry Hill sheep have now largely displaced the Shropshire breed in the counties of mid- and South Wales, where the land is good enough to keep a heavier class of sheep than the ordinary Welsh mountain breed, and numerous flocks are likewise to be found beyond the border in Cheshire, Shropshire, Herefordshire, and Worcestershire.

It is probable that the original Kerry Hill sheep bore some resemblance, as regards markings, to a type of mountain sheep which is common in parts of mid-Wales at the present day, for Mr. Thomas Halford states that the Kerry Hill sheep of about 1840, while they were larger than the pure Welsh breed, had white faces and legs in some cases, speckled with small black spots in some, and tan faces and legs in others. More than thirty years earlier than this, we have an official description of the breed in one of the series of agricultural surveys which were compiled for the Board of Agriculture and issued in the first decade of the 19th century. In the opinion of the compiler of this survey the Kerry Hill was the only sheep that produced perfect wool, that of every other Welsh breed being more or less mixed with the coarse white hair known as 'kemp'. 'The characteristics of the breed', he adds, 'are large, woolly cheeks, white, bunchy foreheads, whitish heads covered with wool, no horns, and a beaver-like tail. They are very hardy and comparatively tame, and not so disposed to ramble as most other hill sheep. In shape, however, they lack compactness and symmetry.' The wool of the Kerry Hill breed, when taken all through, was perhaps not quite so perfect as this description would suggest, for we are told at a later period that while the wool on the body was fine, it was 'so very coarse below that it was always separated from the fleece and sold at a lower price'. The best Kerry Hill wool, from which the coarse portion of the fleece had been separated, was unquestionably of very superior quality.

Up to about 1840, Kerry Hill sheep possessed no great uniformity as regards type. They were bigger and stronger sheep than the pure Welsh mountain breed, but many of them were somewhat loosely built, and the face colour might be white, speckled, or tan. Even then, however, they had a great local reputation for the quality of their wool, and a much wider reputation for their hardiness and the excellence of their mutton. There were undoubtedly many points of resemblance between them and the Clun Forest sheep. Indeed, in many cases at this period of their history no distinction was made between draft ewes of the two breeds, many thousands of which, both from the Kerry Hills and the Clun district, found their way to the lowlands of England, even as far as Kent and Essex, where they were crossed with Leicester and other tups for the production of fat lambs. Kerry Hill ewes, like the Cluns, were regarded as a particularly useful class of sheep for this purpose, being, among other things, excellent nurses.

The improvement of the Kerry Hill sheep as a breed began some time previous to 1850. It is known that during the 'forties many Kerry sheep-breeders made a practice of buying rams from the Knighton district of Radnorshire for mating with their ewes. These rams were apparently of the Clun Forest type, with a certain amount of Shropshire blood. We are informed that it was with the introduction of these rams that the evolution of the modern Kerry Hill breed began. It was not long before the improved Kerry Hill sheep began to have a far greater reputation than their neighbours of the Knighton district. By the late 'fifties the process of improvement had been completely reversed, and instead of the Kerry breeders going to Knighton to buy rams to improve their flocks, we find the Radnorshire breeders coming to Kerry for the same purpose. From this time onwards the Kerry Hill sheep have been improved by selection rather than crossing, and they have now long been regarded as a distinct and a very valuable breed, whose reputation during the last few years has greatly increased.

Modern Kerry Hill sheep have speckled faces and legs, and are generally hornless. Small horns in the rams, however, are not infrequently seen. There is some variation in the face colour, a considerable amount of black being permissible provided it does not extend to the poll, but the uniformly dark face and legs are much less common now than they were. The wool is steadily improving in quality, weighing from 6 to 8 lb. per fleece, and that from the best flocks is quite as fine as any there is in the market. In point of general merit the Kerry Hill breed may be regarded as equal to any breed of its class. It combines the size and

Photo. G. H. Parsons

KERRY HILL SHEARLING RAM

WINNER OF FIRST PRIZE AT THE SHROPSHIRE AND WELSH NATIONAL SHOWS, 1908

Photo. W. S. Berridge

HUNIA OR FIGHTING RAM OF INDIA

BROUGHT BY H.R.H. THE PRINCE OF WALES FROM NEPAL

weight of a lowland breed with great hardiness of constitution, which it has inherited from its hill ancestors. Kerry Hill sheep, moreover, feed and mature rapidly, and the quality of the mutton is always excellent. The ewes are easily kept, requiring, even on very moderate land in exposed situations, but little attention during the winter or at lambing time. They rear their lambs well, and the proportion of twins in well-managed flocks is usually fairly high. Of late years Kerry Hill rams have been largely used for crossing with Welsh mountain ewes for the production of fat lambs. The results are usually satisfactory, and the Kerry Hill has now superseded the Shropshire for this purpose in many parts of the country. Pure-bred Kerry Hill sheep will weigh up to 20 lb. per quarter and more with ordinary feeding. Selected sheep, specially fed, will greatly exceed this weight. The first-prize pen of three Kerry Hill wethers at the Smithfield Show, 1908, had a fasted live weight of 6 cwt. at twenty months old.

The present position of the Kerry Hill breed, and the remarkable progress made by it in recent years, must be attributed largely to the efforts of the Kerry Hill Sheep-breeders' Association and Flock Book Society. The Society was started by a number of Montgomeryshire breeders in 1892, and the first Flock Book was published in 1894. For some years nothing more was done, but the Society was re-established in 1899, and the first volume of the new Flock Book was published. At that time there were 26 members of the Society and 23 registered flocks. The ninth volume of the Flock Book will be published this year (1909), and there are at present 135 members and 123 registered flocks. The secretaries of the Flock Book Society are Messrs. Morris, Marshall, & Poole, Chirbury, Shropshire.

A great show and sale of Kerry Hill sheep is held at the village of Kerry in the beginning of September each year. During the last few years there has been a great demand for pedigree rams, and a large number change hands at excellent prices every year. The highest price obtained for a Kerry Hill ram so far at these sales is 40 gs. This figure has been reached twice, viz. in 1903 by Bahaillon Chancellor (500), bred by Mr. Richard Morgan, and in 1907 by Winsbury Beauty (1822), bred by Mr. T. E. Kinsey. The merits of the Kerry Hill sheep as a breed are such as to make them eminently suitable for many places outside their own district. Some have recently been sold for exportation. In 1906 a consignment of rams was sent to the Government Farm, British East Africa, and in 1907 and 1908 several rams and ewes were purchased for America. With careful breeding and a rigid adherence to type, Kerry Hill sheep, which are rapidly gaining fresh supporters, will become far better known than they are, and are destined to become one of the fashionable breeds of the future. [C. B. J.]

Kestrel.—The Kestrel (*Falco tinnunculus*) is the commonest of British birds of prey. It is easily distinguished, when on the wing, by its habit of remaining poised in the air in one spot, with outspread tail and very rapid motion of the wings, while with its powerful eyes it searches the ground beneath for any mice or small rodents which may show themselves. On these occasions its head invariably points to windward, and this mode of hunting its prey has given it the name of Windhover. The Kestrel's food consists mainly of mice; it scarcely ever touches a bird; and it is one of the farmer's most valuable friends. In southern countries it feeds largely upon insects, such as beetles and grasshoppers. It is a permanent resident throughout Great Britain, but a partial migration takes place in the winter, at which season the birds become more numerous in the south of England, and are correspondingly diminished in number in Scotland and the north. The Kestrel nests in trees, or among cliffs or old towers and ruins. It frequently makes use of abandoned nests of crows, magpies, wood pigeons, &c., and if undisturbed will go year after year to the same place.

Kestrel

It has a sharp, ringing cry, constantly repeated. The plumage is reddish-brown on the back, with head and tail grey, and whitish below with black markings like a thrush. It is easily distinguished from the sparrow-hawk by its predominantly reddish colour. There is not the same difference in size between the two sexes of the Kestrel as is found in the case of many other hawks. [H. S. R. E.]

Kiang (*Equus kiang*).—The wild ass of Tibet is the largest and handsomest of the Asiatic asses. The short summer coat is chestnut in hue all over the upper parts of the body, with the muzzle, the throat, and lower half of the sides of the neck and the belly creamy-white, and sharply contrasted with the tinted areas. The legs also are white, washed with fawn in front and outside; but on the back of the thighs the white does not ascend on to the quarters above the root of the tail, that area being merely paler and more sandy in hue than the rest of the upper side. On the neck the white ascends on each side behind the jaw towards the ear; it also runs up from the belly in front of the stifle joint; just above the white of the belly on each side the chestnut is clouded with black. A

black spinal stripe extends from the mane to the tip of the tail, the tuft of which is mostly black; and the mane, which is full and inclined to fall sideways as in the wild horse, is black in the middle and brownish fawn externally. The ears are black at the base and tip behind, fawn in the middle, and have a conspicuous black tip and external rim in front. In the winter the coat is long and thick, but although the distribution of the colour remains the same, the chestnut loses its brightness and becomes darker and dirtier brown. Good-sized kiangs stand about 13 hands at the withers, and the quarters are often, but not always, conspicuously higher. As compared with the Onager and Ghorkhar, the wild asses of Persia and Western India, the Kiang is a heavily built animal with thicker legs, broader hoofs, and head shaped more like that of a Shire horse.

Northwards in Mongolia and Southern Siberia the Kiang is replaced by the Dziggetai (*Equus hemionus*), which differs markedly from the Tibetan animal in lacking the sharp contrast in colour between the upper and under sides, the latter being whitish fawn and gradually fading upwards into the sandy fawn of the short summer coat or the greyish fawn of the long thick winter coat. Whether the two forms actually intergrade is unknown; so that, provisionally at all events, they may be regarded as distinct though nearly allied species. On the other hand, there are good reasons for thinking that the Dziggetai is linked by intermediate types with the Ghorkhar of Bokhara and Persia. In habits and mode of life the Kiang and Dziggetai seem to be alike. They live in small herds consisting of females and young males, headed by an adult male. They are remarkably swift, and always make for the mountains or rocky ground when chased, their speed and surefootedness in traversing precipitous places baffling all pursuit. But when first startled they make off at a trot, glancing back at the source of alarm and carrying the nose well raised in the air, with the head and neck nearly in the same straight line. Unlike African wild asses, they are very silent animals, the voice being describable rather as a stifled bray, consisting of a squeal and snort, with little resemblance to the bray of African wild asses and Grévy zebras. Although certainly capable of domestication, they have apparently never been tamed and broken to harness so as to be used for draught purposes or riding by the inhabitants of Mongolia and Tibet. [R. I. P.]

Kibbler.—For a description of this implement the reader should consult the art. on BRUISER, CORN.

Kicker, an implement frequently used in hay harvesting. See HAYMAKING MACHINERY.

Kicking. See VICES IN ANIMALS.

Kid, the offspring of the goat.

Kidney, Diseases of.—The kidneys are not specially prone to disease in animals, as they do not suffer from some of the chief exciting causes in their masters, as heart troubles, mental excitement, and alcoholism. Some of the maladies popularly believed to be kidney diseases are treated of under other headings. (See DIABETES; BLADDER, DISEASES OF; and CALCULI.) Many disordered states of the urine arise from constitutional diseases, and are improperly attributed to the kidneys, which carry off morbid products or waste material, and often act vicariously for the skin when that structure fails in its normal functions. Red water is an example. Red urine in such case is not the result of diseased kidney, but of broken-down blood corpuscles. See RED WATER; PURPURA HÆMORRHAGICA.

INFLAMMATION OF THE KIDNEY (NEPHRITIS). — The chief causes are exposure to cold and wet weather, especially in horses when already overheated with exertion. Ruminants are not exempt, but dietetic errors are the more frequent sources of the trouble. In the latter, the consumption of frosted roots and of damaged forage, as mowburnt hay and mouldy straw, excites inflammation. The presence of foreign bodies, and of secondary formations, as tubercles, the release of septic matters in blood poisoning and their arrest in the vessels of the kidney, act as foci of inflammation; other causes are the artificial stimulation of the generative organs through the administration of cantharides, oil of savin, turpentine, and other substances, intended to promote sexual appetite or given for the expulsion of worms, in excessive proportions. Blisters containing these drugs are sometimes absorbed, and mares at œstrum should not be blistered because of their peculiar susceptibility at such times. Strains incurred in jumping and in heavy draught account for some cases, besides the invasion from adjacent tissues when the lumbar muscles are injured, and during the expulsive efforts of parturition in females. In a few instances parasitic invasion is the cause, as when the giant strongle takes up his abode in the pelvis of the kidney.

Symptoms.—A frequent desire to micturate, but with small results. The penis is often extruded, and the animal postures but passes no water or only a very little, and this is high-coloured; and the act is succeeded by a groan, and perhaps shrinking, as if scalded by the irritating character of the fluid. Some pains, as of colic (see COLIC), uneasiness, restlessness, and frequent desire to lie down are observed. Much sensibility is shown when the fingers are pressed over the loin, the animal cringing or crouching to avoid it. Some stiffness of the hind limbs is commonly observed. With the progress of the malady the temperature is raised, breathing accelerated; patches of sweat are seen in horses and cattle with short coats, sheep arching the back and segregating themselves from the flock, with ears and head drooping, and feet close together. The visible mucous membranes are much reddened, and the countenance wears an anxious expression.

Treatment.—An aloetic purge; a diet consisting largely of boiled linseed, and plenty of linseed tea to drink. Hot poultices of bran, turnips, or other heat-retaining materials should be applied to the loins, and small doses of opium frequently administered, changing or alternating the opium with belladonna (see MEDICINES, DOSES OF). Copious injections, per rectum, of

warm water, with extract of belladonna and glycerine, have a soothing effect. If the absence of all conveniences for poulticing necessitates the employment of a liniment instead, ammonia and oil should be chosen, not turpentine or any of the substances previously mentioned as occasional causes of inflammation of the kidneys by reason of absorption. [H. L.]

Kidney Bean. See art. BEAN.

Kidney Vetch, or **Our Lady's Fingers** (*Anthyllis Vulneraria*), is a hairy perennial leguminous forage plant useful for poor dry pastures, especially such as are near the sea and chalky—indeed Kidney Vetch is a good lime indicator. The plant produces underground a short and

Kidney Vetch (*Anthyllis Vulneraria*)

1, Vexillum. 2, Legume.

stout, branched stock, with ground leaves having long petioles and simple narrow blades about 1 in. long. From this stock many air stems arise, and reach the height of 1 ft. or less. These air stems —curved at the base so that mowing is difficult —bear compound pinnate leaves, each with a terminal leaflet specially large. In June, dense heads of yellow flowers are formed at the end of each air stem. These heads usually occur in pairs, each subtended by a green palmate leaf (involucre). The individual flowers have a characteristic baggy (inflated) calyx covered over with white down, and two-thirds as long as the yellow corolla. Later, when the plant is in fruit, the calyx enlarges and encloses the fruit along with the withered corolla in a downy bag which serves as a distributor of the flat one-sided pod within. The glossy seed is easily recognized, for one end of it is coloured yellow and the other end pale-green.

Kidney Vetch is valuable only on the poorest and driest calcareous soils, where clovers and other useful plants cannot be grown. It may either be depastured or mown. For sheep-feed the seed is sown alone in drills 12 or 14 in. apart at the rate of 17 lb. per ac. If sown under a grain crop, the plant makes very little headway and is to a large extent killed out. In a pasture, the plant dies out in about three years, and it is still less lasting if mown for hay. Kidney Vetch is little affected by cold and frost, and it also resists drought well, being a deep-rooted plant. [A. N. M'A.]

Killing of Animals. — The methods adopted in the slaughter of animals are described in the art. ANIMALS, SLAUGHTER OF.

Kilns and Kiln-drying. — Kilns are ovens or heated chambers adapted for drying farm produce—especially seeds and grains—or for burning earthy substances to produce conditions and features not present when they are in the unburnt state. In those kilns which are adapted for curing hops, killing the sprouts of germinated barley, malting the seed, drying seeds in the pod, or for drying fruit and vegetables to preserve them, the flame is not brought into actual contact with the material. But in lime burning, cement making, and in brick making, the fire is brought into actual contact with the material so as to cause incineration. In the first case the object is merely to extract the moisture; in the second, to alter the physical and chemical features as well as to remove the water.

The limekiln is an important institution, because not only is lime used for building purposes, but it also forms one of the most valuable manurial agents at the disposal of the farmer. The value of lime has long been recognized by the agricultural community, and in the past many farmers used small kilns of their own. These were of inexpensive construction, and were generally made by excavating holes on the sides of banks or other suitable sites. In shape they were mostly conical, the inside being lined with stone. Alternate layers of fuel and stone were built up, and as the top portion of the kiln was frequently covered with sods, they were termed sod kilns. Some of these small kilns are still in operation, but as a rule the lime is now bought from the larger kilns.

No very great changes have been made in kilns for a long period, as the types in common use were in vogue a century or more ago, though they have been slightly altered in form, and in some cases the ventilation is improved. Limekilns are classified into *perpetual limekilns* and *intermittent limekilns*. In the former the lime is kept burning continuously for a lengthened period by recharging as part of the burned lime is extracted; in the latter the lime is taken out and the kiln recharged after each burning. In some systems the two practices may be accomplished if desired. A description of a common perpetual kiln will render it more easy to discern the differences in other kinds. It takes

the form of an inverted truncated cone from 12 ft. to 15 ft. in diameter at the top, usually excavated out of chalk or limestone rock, lined with $1\frac{1}{2}$ or 2 bricks, the back being filled in solid with stone set in mortar. The side walls are built upright for about 4 ft.; then the cone is gradually tapered off to a diameter of 3 ft. at the draught or draw hole. Ordinarily the height of the cone equals the diameter at the top. An arched opening in the exterior wall in front of the ashpit is provided, of sufficient height to allow a man to stand upright to get at the firebars to draw the lime. Two strong firebars, known as bearing bars (3 in. by $2\frac{1}{2}$ in.), are fixed into the brickwork so as to be easily withdrawn, and on these, wrought-iron circular bars ($1\frac{1}{2}$ in.) are placed about 1 in. apart. An opening in the front wall immediately over the firebars should be supported by a strong wrought-iron frame built into the brickwork, to give access to the interior of the kiln in order to light the fire, and to dislodge lime should it become wedged. To charge the kilns, the fire should be lighted on the firebars, and when well burning, the hole should be closed, and the feeding done from the circular platform at the top of the kiln, first with coal; when this is burning well, a layer of limestone or chalk, accordingly as either one of these is to be burned, to a thickness of 12 in. When fire breaks through this, put in a layer of coal and then another of limestone; and so on until the kiln is full. When the lime is burned, which will be in about twenty-four hours, draw off the bottom portion and recharge again from the top.

Other types are elliptical or egg-shaped, truncated at either end, forming a shaft. On the whole the egg shape is preferable. The inversion towards the top of these deflects heat. In the intermittent kilns the fuel is not mixed with the stone, but is placed either at the side or bottom of the kiln, and is laid on a grating of fixed firebars, the fire being replenished from time to time until all stone is calcined. These are practically always rectangular, about 14 ft. wide, 12 ft. deep, and 9 to 10 ft. high internally. The walls inside are lined with firebrick; three fireholes run from front to back of the kiln, 1 ft. 6 in. wide, 1 ft. 6 in. high from the bottom of the ashpit to the under side of the bearing bars, and 1 ft. 9 in. from the top of the bearing bars to the under side of the arch. The floor of the kiln is built so as to form a chequer of holes with $4\frac{1}{2}$-in. work. The stone is gradually built up, leaving as much free draught as possible over the holes. In flame kilns, bricks are often burned simultaneously with the lime, from 15,000 to 20,000 bricks being stacked when the kiln is filled with lime up to about 7 ft. or 8 ft.

Malt kilns comprise chambers for wetting barley or other grain to promote its germination, and to regulate the growth of the shoot or acrospire, and to kill or malt the shoot when it has attained the growth desired. The operation briefly consists of steeping the barley in iron cisterns with perforated draining gut for from 72 to 96 hours, the water being run off daily and renewed. It is then turned on to the malting floor, and in cold weather is laid in a layer of from 12 to 18 in. for the first 24 to 26 hours; it is then worked thinner, the growth being largely regulated by ventilation. During this period it is sprinkled from time to time with water, as conditions demand, the object being to induce all the grains to shoot as nearly as possible to a similar degree, so that the acrospire will reach about one-third of the length of the kernel at one period. As samples vary considerably, and several lots may have to be mixed on the floor, great skill is required. The grain is then placed on the drying kiln with a wire-cloth floor, under which is the heating chamber, where it remains until all moisture is driven off and all vitality is destroyed. Until 1881 single-floor kilns were used; but since then it has been shown to be economical to work on double floors, and in some cases three floors are used, the temperature being easy to maintain and control, and labour and fuel are economized. The malt is first dealt with on the upper floor for two days, and then lowered to the second, where it is finished. More recently malting has undergone further changes under special methods, as in Galland's system, where the grain is not sprouted on an open floor, but in a series of closed drums; the gases generated being removed by suction pumps or aspirators, and fresh air being simultaneously drawn in.

Seed kilns are extensively used to dry seeds and corn. A malt kiln answers this purpose well, but on some seed farms the seed is laid over a perforated floor, and hot air is led under it by suitably laid pipes or channels. Many small seeds possess considerable value, and in any but the best weather the risk of allowing them to remain in the field sufficiently long to make them fit to store is very great, and the process is well warranted. Kiln-drying is sometimes practised to condition musty grain, and is then less warrantable, as it may prove injurious to animals consuming it. [W. J. M.]

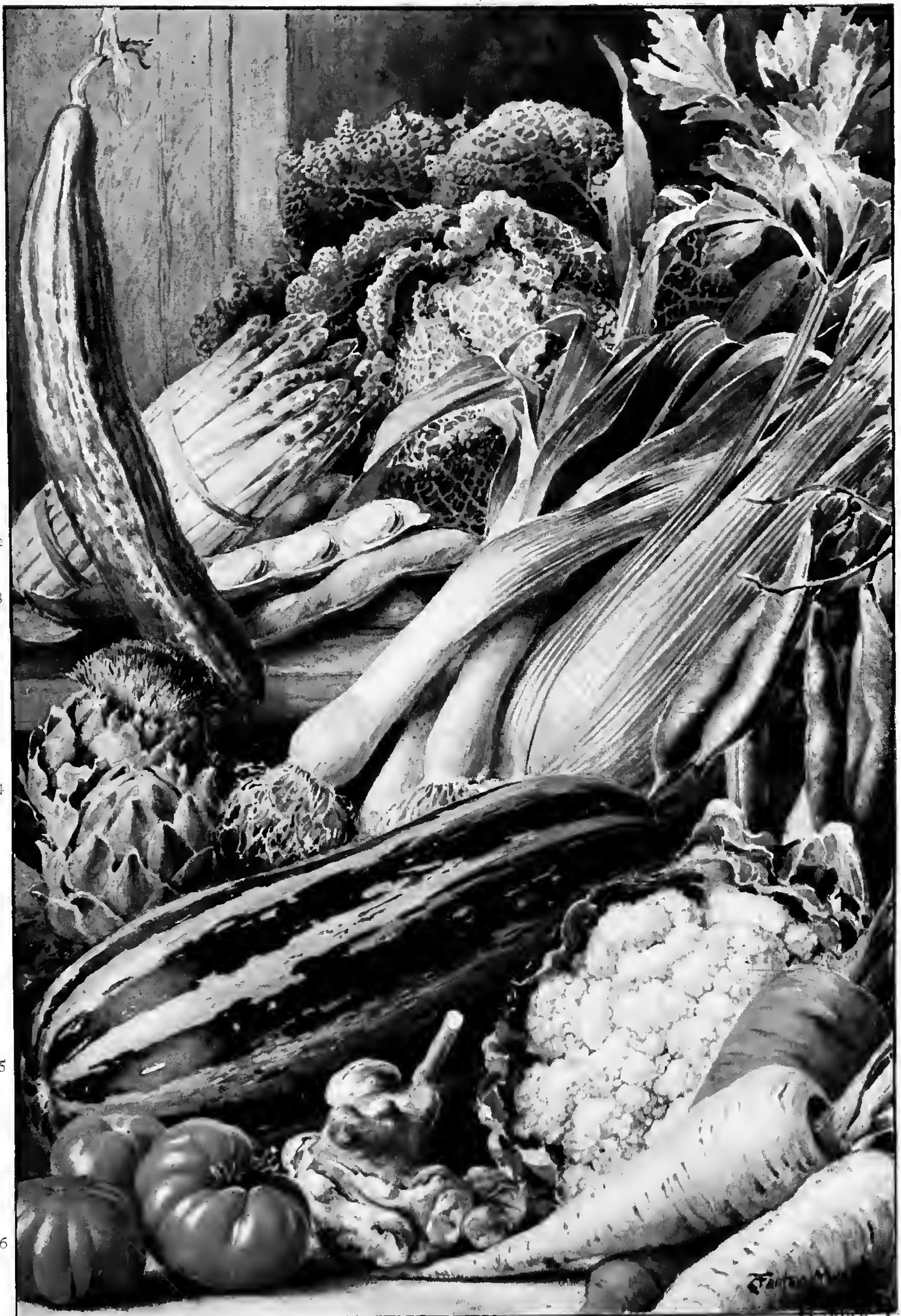
Kingfisher (*Alcedo ispida*).—This beautiful little bird, scarce in Scotland, and only found as a straggler in Ireland, is a stream-haunting species, distinguished by its brilliant plumage, in which metallic blue, chestnut, and black are the predominant hues. The feet are adapted to grasp a branch without effort or fatigue for a long time together, and the strong, sharp beak is much elongated. For nesting purposes a long tunnel is excavated in the bank of a stream, and the six to eight globular eggs are deposited on a litter of fish bones. They are deep-pink until blown, when they assume a china-white colour. As the food consists almost entirely of small fishes, the species is of no agricultural importance. [J. R. A. D.]

Kirn, or **Kern,** a local name applied in many parts of Scotland to the harvest festival, for a description of which the reader is referred to the article under that heading.

Kitchen Gardens.—A kitchen garden is that portion of a residential estate reserved for the cultivation of vegetables, herbs, and hardy fruits, the more favoured positions against walls or espaliers being occupied by the latter.

As in the cultivation of trees, vegetable culture is largely dependent for its ultimate success

13
14 (in centre)



1 2 3 4 5 6 7 8 9 10 11 12

VEGETABLES

1, Cucumber; 2, Asparagus; 3, Broad Beans; 4, Artichoke; 5, Vegetable Marrow; 6, Tomatoes; 7, Jerusalem Artichoke; 8, Parsnips; 9, Carrot; 10, Cauliflower; 11, French Beans; 12, Celery; 13, Savoy; 14, Leeks.

upon the natural character of the soil; and hence when choosing a site for a kitchen garden it becomes essential to carefully examine the nature of the subsoil, the qualities of which should be the best obtainable. Considerable expense will be avoided where the ground possesses a natural means of drainage, and in such positions it is immaterial whether the surface is perfectly flat or slightly sloping. Many authorities, however, contend that a slope a little to the east of south is best, in order that the sun's rays may strike the ground just before midday. Low-lying districts never afford favourable sites for a kitchen garden, the soil being unduly heavy and moist, thus preventing the early sowing and planting, so essential to the production of early crops. A further evil in these localities are fogs and late frosts, which only too frequently dispel all prospects of a fruit crop. A good supply of water is an essential point, and should find its origin preferably in a natural source. As with greenhouse plants, the temperature of water given to crops growing in the open should be similar to that of the air in which the crops are growing.

A kitchen garden should always be situated within a convenient distance from the house, and screened from the view of the principal windows and approaches by belts of trees or shrubs.

The most favourable soil for the cultivation of the majority of hardy fruits and vegetables is a deep medium loam, of a nature more pertaining to that of a moist, sandy texture than a stiff, retentive character.

In many of the best kitchen gardens celebrated for the production of exhibition vegetables, the continuous admixture of animal manure and the many forms of vegetable matter has transformed the original soil into an ideal growing compost, possessed of all the essential qualities for the growth of deep-rooting crops. Twenty-four inches may be regarded as the average depth of a good garden soil, and this will be found sufficient for all classes of vegetables; where shallow soils cannot be avoided, or where the subsoil is of an inferior nature, these should be improved as much as is practicable and economical by the introduction of suitable soil from other sources. Variation in the character of the soil of a kitchen garden from a heavy loam to that of a light sandy nature is a favourable indication, as one can thereby comply more conveniently with the special soil requirements of the various crops. The condition of the subsoil is of vital importance where it is intended to raise choice fruits; the roots of young trees when in contact with a gravelly stratum or soil of an injurious character soon decay and induce canker in the branches, subsequently weakening the whole structure of the tree, and ultimately paving the way for the ravages of insect pests and fungoid diseases.

The actual size of the garden, the extent of wall surface and glass area, and the space allotted to sheds and other necessary structures, are considerations entirely dependent upon the owner's requirements and the amount he is prepared to expend.

The advantages of a walled-in garden are both numerous and varied: the walls, which should be as far as possible of a southern aspect, provide substantial shelter, and can be utilized for the cultivation of hardy and half-hardy fruits that may not succeed or ripen with certainty in more open situations. Fruit trees suited for various aspects can be selected—apricots, nectarines, and peaches; also some of the finer varieties of pears may occupy the south walls, and those with a westerly aspect can be occupied with plums and cherries, while in some localities apricots will succeed in such positions. Walls with an eastern exposure are well adapted for plums, and many excellent varieties of culinary and dessert pears not sufficiently hardy for open situations; walls facing north, while not affording encouragement to the finer classes of fruits, are nevertheless serviceable in the production of Morello cherries, also late currants and gooseberries.

In the majority of well-planned gardens a sloping border is constructed equal in width to the height of the wall, and is admirably adapted to the forcing or retarding of growth, according to its aspect and the manner in which the soil has been prepared. The central plot should be subdivided into quarters according to size, the divisions being marked by paths, either of gravel or of the original turf. Specially reserved spaces should be set aside for glass structures, their position affording an abundance of sunlight.

Walls, while forming an admirable protection against wind, often cause a strong gale to sweep along the top and descend on the other side, thus greatly damaging the trained trees and the many choice and tender plants occupying the borders below. It therefore becomes essential that winds, particularly from the east and north-east to north-west, be broken by a belt of trees or shrubs placed at convenient distances from the walls, and, where space admits, nothing is more effective in this respect than a screen composed of some quick-growing trees such as Scotch firs, poplars, larches, elms, or whatever is most suitable to the local soil. The southern side of the garden should be left as open to light and air as is possible, and on no account must trees planted for shelter be allowed to deprive the garden of light and air by overhanging branches, or of nourishment through the action of their roots.

The object in cropping a kitchen garden should be to obtain a regular succession of vegetables throughout the year. If we assume that the area set apart for vegetable culture is divided into four plots, roots such as carrots, beetroots, parsnips, &c., must be kept together and not scattered indiscriminately over the garden; potatoes may occupy a plot to themselves; peas, beans, and other legumes a third plot; and onions, celery, and leeks a fourth.

When the ground occupied by onions is cleared in August, it may immediately be dug over and planted with spring cabbages. After the other autumn crops have been removed, the ground can at once be manured and, if need be, trenched, thus putting it in readiness for an early crop of cauliflowers and brussels sprouts;

it could also be used for very early potatoes, which ought to be ready for lifting in July, thus giving place to winter and spring broccoli. In either case, this arrangement will be a distinct change of cropping, and will admit of plants of the Brassica tribe being kept together. On the plot reserved for peas there is nothing to prevent summer spinach, radishes, and other salad crops being grown between the rows of the dwarf varieties; and when the majority of the peas have been gathered, the ground may immediately be dug over and planted with brussels sprouts, kale, or winter broccoli, the latter being planted as the ground becomes vacant up to the middle of August. The removal of the late peas affords ample opportunity for the formation of celery trenches, which, if sown with strong-rooted plants, will furnish a useful main crop. To still further economize the ground, the intervening spaces between the trenches can be planted with coleworts, which may be cut in autumn without hindering the work of earthing up. In further consideration of this particular plot, it will be seen that the celery provides a good preparation for deep-rooted crops such as onions, parsnips, beetroot, or carrots.

In soils of a heavy retentive character, a quick-growing crop of short duration should follow the spring broccoli, in order that the ground can be ridged up for the winter; this could be effected by growing potatoes, kidney beans, or turnips, which will be ready for removal at the same time as the other occupants of the plot. The whole plot can thus be given a rest, in view of its having been heavily cropped in the previous winter. The plot devoted to early potatoes will form a good position wherein to plant cauliflowers, Walcheren broccoli, kale, sprouting broccoli, and savoys, if desired.

Permanent crops, as asparagus, artichoke, rhubarb, seakale, and the many varieties of bush fruits that claim a position in the kitchen garden, should be kept separate from those plots where a definite system of rotation is followed. The same remarks are applicable to the cultivation of herbs, which, if mingled with the general culinary crops, constitute an interference; and the digging and trenching operations, which are so prevalent during the winter, render the herbs, which at this time are lying dormant, liable to destruction. [J. C. N.]

Knackery.—This name is given to premises where the business of slaughtering worn-out horses is carried on, and their carcasses converted to commercial uses. They are conducted under strict regulations of local authorities, and one of the rules governing the business forbids the knacker, under a heavy penalty, to allow an animal to pass out alive from licensed premises. The men employed are, as a rule, skilful with the poleaxe, and no unnecessary pain is caused to animals. In many knackeries situated in cities, the humane 'Greenyer killer' is used, whereby all chance of a by-blow is eliminated. The unfortunate owners of cattle which have died or been condemned to death on account of disease, and who do not present carcasses to the nearest pack of hounds, make use of the knackery, the proprietors having specially constructed carts fitted with winch and chain for winding the carcass upon it. In most cases it is a more economical proceeding to sell a dead or dying animal for the value of its skin than to engage farm hands to flay and dispose of the carcass, as a good deal of skill is required, and more dexterity than is to be expected of the average labourer. The digging of a sufficiently deep grave proves a more protracted labour than is anticipated by those who have not previously performed it. Neat's-foot oil and horse oil are generally to be obtained in their genuine state from knackeries, spurious imitations of the former being frequently sold which consist of linseed oil slightly saponified and made to appear cloudy by the addition of a little liquid potash. In London and other great centres, knackeries are carried on by companies yielding a handsome dividend, the business being a profitable although very unattractive one, and formerly conducted by a very undesirable class of men. A properly equipped knackery should be provided with a steam destructor for glandered horses, as it is not possible for town owners to bury six feet deep and cover with lime, as advised in the case of animals so diseased in the country. A regulation in force in many boroughs requires the slaughterer to cover the bodies of animals effectually, even to leg drawers, on their way to the knackery, but this refinement is not yet universal. The knackery has suffered seriously of late years from the competition of the Continental horse butchers, who have agents in this country to purchase cripples and deport them to Hamburg and other cities where horse flesh is valued for human consumption; and, the best being thus taken out of the country, a shortage of such meat is experienced at home, where it has not hitherto been employed for human food, although fit for the purpose. Glue and other substances are made, or the portions suited to various commercial uses disposed of. See ANIMAL PRODUCTS. [H. L.]

Knapsack Sprayer. See SPRAYERS.

Knapweed, a purple-flowered perennial weed common in pastures. See CENTAUREA.

Knee, Injuries to. See art. BROKEN KNEE.

Knife.—Knives of various kinds are required on the farm. The hay knife is the most important, no machine yet having been made suitable for cutting haystacks. Hay knives take two forms—the ordinary large steel blade with cranked handle, and the more modern wavy-edged tool. As these are well suited to cut out the hay in trusses, it is difficult to see in what way they can be improved. Paring knives are made with a scythe-like blade, but straighter, for paring the sides of stacks to make firm sides, and for cutting the eaves of thatch. The footrot knife is indispensable where a flock of sheep is kept, as from time to time the feet must be pared or footrot will be induced, or when footrot is established the hoof must be pared away clear to the seat of the disease. A strong knife of good steel, a slightly curved in preference to a straight blade, the blade tapering so as to work easily between the digits, and a full handle,

are the essentials of a foot-paring knife. The fruit-tree pruning knife is made somewhat similar to the footrot knife, but a bigger, broader blade is desirable. The hop-pruning knife is a much larger fruit-pruning knife, and is employed to trim the root sets. The slaughtering knife is a stout, sharp-pointed, straight knife, suitable for sticking animals. To the farmer a good pocket knife is a necessity, and should contain a frog-hook to release stones from horses' feet, a screwdriver, gimlet, &c., in addition to a large and small blade, and a cork-screw—to take the cork out of medicine or other bottles; for, on going round a farm, a farmer has frequent need for one or other of these. The knife of the mowing machine is composed of a number of triangular sections attached by rivets to the knife bar. [W. J. M.]

Kniphofia (Torch Lilies, Red-hot Pokers, or Flame Flowers), hardy herbaceous perennials, with scarlet and yellow flowers, natives of Africa and Madagascar, known also under the name of *Tritoma* (nat. ord. Liliaceæ). The peculiar merit of these handsome and distinct border plants is that most of them flower in late summer and autumn when the summer glories of the garden have diminished, and their principal demerit is that they require some degree of protection in winter in the north. Kniphofias delight in a light sandy soil, with abundant topdressings of manure, and they should have plenty of water in summertime. Somewhat ragged in appearance, they do not combine well with other plants, and should be grown in beds by themselves, or in irregular masses in open situations (particularly in proximity to water), or with a background of taller plants. The stemless kinds are easily propagated by division or from seeds. The sorts with stems should be cut down, when they will produce a number of offshoots, which may be cut off after they have formed roots. The principal species include: *K. aloides*, the Flame Flower of cottage gardens, of which there are several good varieties, including *nobilis*, which attains to 7 ft. in height; *K. Burchelli*, *K. caulescens*, and *K. Northiæ*, of caulescent habit; *K. Macowani*, of dwarf habit; and *K. Rooperi*, which has glaucous leaves, and flowers earlier in the summer. *K. rufa* has elegant spikes of orange-yellow flowers, and is gay all summer. There are now a large number of excellent hybrid kinds, most of which have been derived from *K. aloides* crossed with other species. [W. W.]

Knotgrass is the name applied sometimes to the bulbous variety of False Oat Grass (see ARRHENATHERUM) and sometimes to a plant which is not a grass but a member of the Dock family, viz. *Polygonum Aviculare*. This species of Polygonum is a common worthless annual weed of dry ground. Many wiry branch stems spring from the root and spread out along the ground when there is an opening, but in corn or among grass these stems become drawn up and erect. The stipules at the base of each leaf form a short white tube (ochrea) round the stem less than ½ in. long, and ragged at the edge. The flowers are small, in clusters of two to five, in the axils of most of the leaves. The fruit is a three-faced nut, of a brown colour, not at all glossy, and covered by the persistent perianth of the flower. [A. N. M'A.]

Knots.—Knots of several kinds are usefully employed on the farm. In binding corn sheaves with straw bands the two ends of the band are brought closely together around the sheaf, and then both are twisted so much, that on doubling

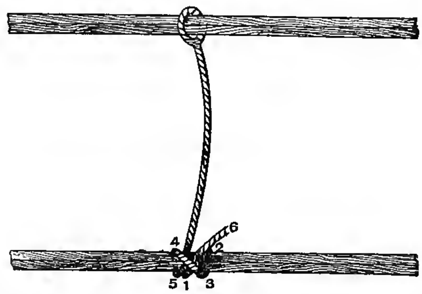


Fig. 1.—Rope knot, convenient for tying ropes on cart shafts and other places. Numbering shows the loose end passing under and over shaft. When the last turn is drawn tight, press the loose end sharply down, when it will clip between shaft and 3 and 4. It will only tighten when more strain is put on it from opposite end.

a portion of the band under the encircling portion a kink is formed which, with the pressure of the sheaf, keeps from loosening. For tying sacks containing chaff, three or four wheat straws will secure the mouth sufficiently for all purposes on the farm, and in many districts where chaff is much used for sheep, straw is always used. If the straws are twisted round the mouth so as to leave about 10 in. of both ends free, and these are twisted round until on pressing them towards the sacks they kinkle, all that is necessary is to make the kinkle form first close to the sack, when it will screw itself into a secure knot. This is convenient also for corn sacks if string is not available. A good knot for tying rope round cart shafts or anywhere there is tension on the rope is shown in fig. 1. It does not require a hook or stop, as many other methods of tying ropes do. Used as a belly band, or for tying on loads, the rope is first brought under the shaft, the end turned over the shaft towards the right-hand side. Bring it under, and turn it over the shaft towards the left, but before pulling tight, slip the end through the loop; then pull tight, and with a jerk press down until it is pinched between the loop and the under side of the shaft. It will then be secure, as increased strain will tend to tighten it. Fig. 2 shows a useful form of surgical knot applicable for general purposes. [W. J. M.]

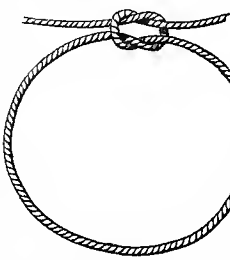


Fig. 2.—Useful surgical knot. Being non-slipping, may be used for many purposes on the farm.

Kohl-rabi.—The Kohl-rabi (*Brassica oleracea*, L., var. *caulo-rapa*), or 'turnip-rooted' cab-

bage as it is sometimes called, is a 'race' or fixed variety of the cabbage, and is not related to the turnip. The leaves are glaucous, somewhat thinner than those of the cabbage proper, quite smooth even when very young. The flowers are somewhat large, pale-yellow, and the seeds a dull greyish-brown. In the form of its leaves, and in the character of its flowers, seeds, and root system, it very closely resembles the cabbage. The part of its primary stem, however, above its cotyledons thickens, and grows ultimately into a spherical turnip-like structure, from the apex and sides of which the leaves develop. As the 'bulb' thickens, the leaf-bases expand, and the scars left after the fall of the leaves are seen as transverse crescent-shaped marks.

The 'bulb' differs from the turnip and mangel in being a development of the epicotyledonary

Kohl-rabi

part of the stem, and not a thickened hypocotyl and root as in the latter plants. It stands well above the ground, resists frost, and grows well in dry seasons, when other root crops suffer from drought.

Two principal varieties are usually grown for cattle and sheep, viz.: (1) the Green Kohl-rabi, with smooth, greenish-white leaves and 'bulb'. The kinds with large roots and suited to the colder soils usually have luxuriant leafy tops, those with smaller 'bulbs' and few leaves are more adapted to warm soils. (2) Purple Kohl-rabi, with violet or reddish-purple 'bulbs' and leaf-stalks. On the Continent a number of delicate varieties are grown in gardens for use as table vegetables. [J. P.]

Of recent years kohl-rabi has frequently been recommended to the use of farmers as a crop which is capable of providing excellent green food in autumn and early winter for the use of both cattle and sheep. The growth of the crop, however, is confined to the southern and midland counties, and it seems practically unknown in the north of England and Scotland. This no doubt is due to the fact that it is more like the mangel than the turnip in its requirements, being particularly suited to medium and heavy loams in a dry climate.

Kohl-rabi is more of the nature of a cabbage than a turnip, and the succulent bulb which is found above-ground may be described as an enlarged stem which has been abnormally developed for the purpose of providing a large bulk of nourishing food for stock.

As already mentioned in the botanical description, there are several varieties in cultivation, some being purple and others green in colour. Of the green sorts, the short top is the largest growing variety, and comes earliest to maturity. The other green variety with a coarser top is not so early, but it is exceedingly hardy and nutritious, and better able to resist frost than the former. The crop is frequently grown in the Fens, especially on land where they are unable to make sure of good crops of turnips and swedes owing to lack of lime in the soil, and the consequent prevalence of finger-and-toe. The experience of several good farmers, however, who have tried kohl-rabi as a substitute for other roots, seems to show that in ordinary seasons when there is sufficient moisture the yield of feeding material per acre where kohl-rabi is grown is not nearly so great as from good crops of swedes and turnips. In fact, it may be said on good authority that an acre of turnips would last a hundred sheep for a period almost half as long again as an acre of kohl-rabi grown on the same soil under similar conditions.

Cultivation.—The cultivation of the kohl-rabi is similar to that of the turnip, and it takes the same place in the rotation, generally following a white straw crop, although it is necessary to prepare the actual seedbed somewhat earlier in the year. Where the soil is of a retentive nature and clean, it is advisable, as soon as the corn is removed, to fork any patches of couch which may be apparent; the stubble is then deeply ploughed in the autumn after giving a good dressing of farmyard manure at the rate of 10 to 12 tons to the acre. The furrow is afterwards left exposed to the winter frosts and the ameliorating effects of the weather, not being touched again till early spring. When dry enough, a preliminary harrowing may be given to level the surface and destroy any small weeds; after which the cultivator, working in both directions, followed as the circumstances may require by harrow and roll, prepares the actual seedbed, which must consist of 6 to 8 in. of crumb, firm but mellow, and able to retain sufficient moisture for germination to take place. The seedbed is then ready for sowing. These, however, are ideal conditions of cultivation, and in the majority of cases it will be found necessary to broadshare or shallow plough the surface of the stubble soon after harvest, and by means of the drags, harrows, &c., to remove one or more coatings of couch and other weeds. This process may have to be again repeated in spring should any live weeds of a deep-rooting nature still remain in the soil; and two or even more ploughings may be necessary before a proper seedbed can be prepared. The application of

farmyard manure will also have to be deferred in these cases till the cleaning operations are finished, when it is applied in a rotten condition before the final ploughing.

The seed should be drilled in April at the rate of about 4 lb. per acre at a distance of 18 to 24 in. between the rows, the single plants afterwards being thinned out to a distance of 12 in. or more apart in the rows as required. As soon as the young plants begin to appear, the horse hoe should be set to work between the rows. The hand hoes then follow, and the process of singling is carried out as soon as the plants are strong enough. The seed is generally drilled on the flat, as is customary with most root crops in the drier climate of the south and east of England.

As an alternative to the method of sowing the seed in drills and thinning out, the seed may be sown in a large seedbed, the plants afterwards being transplanted into the field. In this case 1 lb. of seed sown on some 6 to 7 sq. yd. in March will provide sufficient plants to set an acre in May or June. This method of taking plants from the seedbed, however, is more applicable to filling in blanks among the other root crops on the farm than for growing the crop in the ordinary way in the field.

Manuring.—Kohl-rabi is somewhat of a gross feeder, and will therefore stand heavy manuring. It requires large quantities of the three principal manurial ingredients liable to run short in the soil, viz. nitrogen, potash, and phosphoric acid. As it is, however, generally grown with liberal supplies of dung, and often on soils containing sufficient abundance of decaying vegetable matter, it does not require extra supplies of the first two ingredients. Phosphoric acid, on the other hand, as in the case of turnips, is often deficient; and it will pay, as a rule, to supplement the farmyard manure with a dressing of a few hundredweights per acre of some readily available phosphatic manure, such as superphosphate of lime. This should be sown at the time of planting, either being drilled with the seed, or sown broadcast by hand at the rate of 3 to 4 cwt. per acre. A small dressing of one of the concentrated nitrogenous manures, such as sulphate of ammonia, may be applied at the same time at the rate of ½ cwt. per acre; or a similar quantity of nitrate of soda may be used as a topdressing after the plants have been singled. Heavy dressings of nitrogenous manures at the time of sowing and at frequent intervals during the period of growth do not seem to yield a sufficient increase in weight of crop to justify the expense, as in the case of mangels and cabbage. Without dung, double the quantities of the above artificial manures should be used, with the addition of 4 to 5 cwt. of kainite, or its equivalent in sulphate or muriate of potash. In this case, half the nitrogenous manure may be applied as sulphate of ammonia at the time of planting, and the other half as nitrate of soda after the plants are up.

Where the land is liable to finger-and-toe it will be found best to substitute basic slag as the phosphatic manure in preference to superphosphate and dissolved bones, on account of the acid properties of the latter.

The crop will be mature and ready for feeding off at such a date in the autumn according to the earliness of the variety. The later sorts are very hardy and resist the frost well, but if it is desired to keep the bulbs for winter feeding it will be necessary to raise the crop and bury in small pits or clamps covered with earth about the field, in a similar way to swedes. These pits can be opened by the shepherd as required, as he moves his fold over the ground. Sheep are generally allowed to consume the bulbs in the whole state, but when they are drawn home and used for cattle they are sliced in the ordinary way.

The small wiry stalks which attach the bulbs to the root, and which are left on the ground after the crop has been consumed, are sometimes objected to by farmers as being difficult to get rid of. If, however, proper care is taken in setting out the furrows in ploughing the field after the crop is consumed, the rows of stalks will be buried in the bottoms of the furrows, and put entirely out of the way for the subsequent cultural operations.

Kohl-rabi may be described as a nutritious green food, with a flesh having a taste similar to cabbage leaves, which is much relished by both cattle and sheep.

From analyses, kohl-rabi bulbs show a greater percentage of dry matter and also of total feeding material than either the roots of swedes or mangels. The crop, however, should be fed off before it becomes too old.

Table showing the Percentage Composition of Swedes, Mangels, or Kohl-rabi, as the mean of a number of analyses.

	Swedes (roots).	Mangels (roots).	Kohl-rabi (leaves + bulbs).
Water	89·0	88·0	86·0
Crude albuminoids...	1·4	1·1	2·1
Carbohydrates ...	7·7	9·1	9·3
Fibre	1·3	1·0	1·4
Ash	0·6	0·8	1·2
	100·0	100·0	100·0

In conclusion, attention must again be drawn to the fact that kohl-rabi will not in ordinary seasons provide such a bulk of feeding material to the acre as good turnips and mangel; but on soils where there is difficulty in getting a good plant of turnips, and in dry summers, kohl-rabi may be found of the greatest value in providing a sufficiency of winter food for stock. It is also well to bear in mind the use of kohl-rabi for patching blank spaces in root crops, and for this purpose it will pay in most years, where the climate is suitable, to have a seedbed for providing plants for filling in vacant spots.

[D. T.]

Kola (Cola or **Goora) Nuts** are the seeds of a small tree, *Cola acuminata*, Schott and Endl., nat. ord. Sterculiaceæ, indigenous to West Tropical Africa, especially in the vicinity of the coast, though now extensively cultivated

in the West Indies, Brazil, &c. It attains a height of 30 to 40 ft., has smooth leaves 6 to 8 in. long, pointed at both ends, bears yellow flowers spotted with purple, and forms large fruits which, when ripe, split lengthwise into follicles that contain the seeds (nuts). These are extensively traded in throughout Africa and to all countries where African slaves were taken or emigrants had gone. With the negroes the nuts are held in superstitious reverence, and constitute an important item in the presents of the bridegroom to his bride's father. They have powerfully stimulating properties. A small piece, chewed before meals, is believed to promote digestion, to improve the flavour of food, and to allay both thirst and hunger. The nut is also reputed to purify water. Recently a traffic in kola nuts has been organized with Europe and America, where they are seemingly employed in the production of a beverage, or are worked up into a paste (similar to chocolate) which is regarded as a nutritious article of food, containing about 2 per cent of caffeine. In many respects kola resembles coca leaf (*Erythroxylon Coca*), the masticatory of the Andes and Peru from which cocaine is prepared, and perhaps more closely the cocoa nibs, the seeds of *Theobroma Cacao*, of which chocolate is made. [G. W.]

Koumiss, an alcoholic beverage prepared from milk by the action of special micro-organisms. Koumiss was originally prepared by the Tartars from mare's milk, but is now also made from cow's milk. The sugar of mare's milk more readily undergoes alcoholic fermentation than that of cow's milk, but during recent years many special organisms have been discovered which are capable of producing alcoholic fermentation of the ordinary sugar of cow's milk. This comparatively easy fermentation of lactose has made possible the preparation of many alcoholic beverages from milk and milk products which are very much like the original koumiss. One kind of koumiss may be prepared by adding a little cane sugar and yeast to skim milk. These alcoholic beverages prepared from milk contain a certain amount of carbonic acid, which makes them foaming or effervescent; the peptonized condition of the casein also adds to their dietetic value, and accounts for the name 'milk champagne' which is sometimes given to koumiss.

The following is an analysis of mare's milk koumiss (Fleischmann):—

Water	91·53
Milk sugar	1·25
Lactic acid	1·02
Proteins	1·91
Fat	1·27
Alcohol	1·85
Carbonic acid	0·88
Mineral matter	0·29
	100·00

Preparations made from cow's milk are of somewhat similar composition.

A point of special interest in the analysis of these beverages, and also in the analysis of old samples of decomposed milk, is the determination of the alcohol, which is made as follows. About 100 grm. of the fermented milk are distilled till approximately half the liquid has passed over, the distillate is then neutralized with tenth normal caustic soda solution, litmus paper being used as the indicator. The liquid is then redistilled, and having been made up to a convenient bulk, the density of the second distillate is determined in a 50-grm. pycnometer. The quantity of alcohol is deduced from a table.

Kephir is another alcoholic beverage, of a somewhat similar nature to koumiss, which has been in use for many years in the Caucasus. It is made by the action of a special ferment, known as 'kephir grains', on cow's milk. These grains, which are hard, yellow, granular lumps about the size of a pea, contain a number of different kinds of moulds, yeasts, and bacteria; when put into water and soaked they swell, and produce an alcoholic beverage in milk after it has been added two or three days. The grains can then be taken out, dried, and kept for future use.

The nature of the fermentation is complicated in both koumiss and kephir, and consists not only of the alcoholic fermentation of the milk sugar, but also lactic fermentation, together with proteolytic and other fermentative changes in the nitrogenous constituents of the milk. [J. GO.]

Kyloe. See HIGHLAND CATTLE.

L

Label.—Labels for indicating the names of plants are indispensable in the garden; and while opinions differ as to the extent to which they should be used, it must be pointed out that their absence, or the employment of perishable kinds, is a perennial cause of confusion. It is almost the rule for the identity of fruit trees to be lost, and certainly, in their case, labels of a permanent kind should be affixed at the time of planting, an alternative method being to make a plan of the plantation. For endurance, nothing excels the labels in use at Kew and other public gardens and parks. These are cut from sheet lead, the names being stamped upon them with metal type and made conspicuous by a filling of white enamel. They are hung on to trees and shrubs with galvanized wire, while for herbaceous plants they are screwed on to iron pegs which are stuck into the soil. Wired labels must be occasionally examined to see that the wires are not cutting into the bark. Of the great variety of other kinds of label in use, those of plain wood, lightly smeared with white paint to display the writing, are most in vogue; but mention may be made of tie-on labels of metal so soft as to be readily indented by a pencil, as

being very useful for plants with stems. The common expedient of labelling seed rows by placing the empty seed packet in a cleft stick is an exceedingly bad one, as, even if the paper does not blow away, the information upon it quickly becomes illegible. [W. W.]

Labiatæ is the name applied to the nat. ord. of dicotyledonous plants which includes Mint, Thyme, Lavender, Patchouli, Sage, and Horehound. The important weeds belonging to this order are Dead Nettles and Self-heal, an indicator of poverty-stricken pastures. Labiatæ are distinguished from other dicotyledons by the following characters: (1) Stem square; (2) leaves opposite; (3) corolla with petals grown together and two-lipped; (4) stamens four, two long and two short, attached to the petals; (5) ovary four-lobed inside of the flower, and, when ripe, forming a fruit composed of four nutlets. [A. N. M'A.]

Labour Colonies.—Labour colonies are farms adapted for the reception and employment of a large number of men. They originated in Germany, where the first farm colony, that of Wilhelmsdorf, was opened in 1882. They were designed by their founder, Pastor von Bodelswingh, to destroy vagrancy and begging by providing places where every man who professed to be seeking work could find it, and would be provided with food and clothing in exchange for it. The first colony proved so successful that others were soon instituted, and there are now forty or fifty similar colonies in Germany, while the system has extended to other countries. In England the first colony was opened by the Salvation Army at Hadleigh in Essex, and at a later date the first was formed in Scotland at Midlocharwoods in Dumfriesshire by the Scottish Labour Colony Association. Other similar colonies have since been formed in both countries.

The primary purpose of the system is to diminish the inducements to vagrancy and begging, to provide a refuge for men in destitution and out of employment, who can there be provided with both food and shelter, and to place such men, the majority of whom have undergone moral and physical shipwreck mainly through the influence of drink, under such conditions as may tend alike to their physical and their moral restoration. The labour of men of this class is so inefficient and so unskilful, that it is difficult to apply it on farm operations capable of giving an adequate return. Hence none of the colonies are self-supporting, but have to meet annual deficits by funds derived from charitable or other sources. The amount of deficit likely to be incurred varies greatly, however, and much depends on the proper selection of a suitable farm for the colony, as well as on the skill of the management. In general, farms are selected for this purpose containing a large area of land capable of reclamation and improvement, and likely to give in the improved value of the land some return for the labour expended on it. On one of the German colonies there is an interesting example of a tract of poor soil which has been greatly improved by digging to a depth of about 3 ft. down to a hard iron pan of some inches thick, which when broken and thrown up has crumbled on exposure to the air, and has mixed with and improved the surface soil. On another, where a field of poor dry sand lay adjacent to a wet moss, the surface of the latter was dried by covering it with a layer of sand to the depth of 1 ft., taken on to it in wheelbarrows, after which the sand was dug into the upper layer of the moss. By this means a soil was obtained capable of being cultivated and of yielding much better crops than could be grown separately either on the sand or on the moss. Besides affording such examples of agricultural improvement, the labour colonies also form sources for the supply of farm labourers, of which advantage may be taken by farmers in times of emergency. At seedtime or at harvest, or any other period of special work, or in the event of any men being suddenly laid off for a time by accident or illness, labourers can be obtained from one of the colonies, and the men on them, many of whom are of superior education and intelligence, after a few months' residence and training often become fairly efficient workmen. [R. P. W.]

Labourer, Farm.—In this article it is proposed to discuss, firstly, the status of the farm labourer in regard to the conditions under which he works, the duties he has to perform, and the remuneration he earns; and secondly, his training and education.

1. Status of the Labourer.—Included under this term 'labourer' are the farm bailiff, the farm steward—in Scotland called 'grieve'—who directs the operations of the other labourers, the ploughmen, the cattlemen, the shepherds, the byremen, the pigmen, the dairy workers, and the outworkers casual or regular, male or female. In a way, also, the drainer, the ditcher, the hedger, and other such workers, inasmuch as they work on the farm, may be called farm labourers. On many farms, especially those of the smaller size, and particularly dairy farms, the farmer himself and his wife and family do more work than any labourer about the place. Generally, however, the term 'farm labourer' is restricted to the hired labourers employed by the farmer to assist him in carrying on the work of the farm.

The work of the farm labourer is very bracing and healthy. It is for the most part conducted in the open fields, where the labourer is brought into closest contact with Nature in all her varied forms. The farm labourer has to bear the rigours of winter, when the land has to be ploughed, when the stock have to be fed, and the crops of the preceding season have to be threshed and marketed. He has to be busy in the springtime, when the lambs are dropped and the land has to be seeded. He has to hoe the potatoes or the turnips in summer, and make the hay while the sun shines; and later on comes the harvest in the autumn, when the crops have to be reaped and gathered in. By means of their open-air employment the sons of the soil are for the most part a particularly healthy and hardy race, and their families, reared in such surroundings, are robust and

vigorous to a degree. In respect of healthful surroundings the farm labourer and his family have a great advantage over the worker who is reared amid the grime and noise and unhealthful surroundings of the great industrial centres; and as a matter of fact the cities are not more dependent on the farm labourers for their supplies of daily bread and milk and butter than they are upon the country for a regular supply of fresh vigorous blood, without which the stamina of our townspeople could never under present conditions be maintained.

The conditions under which the farm labourers live and work in the country are very varied. In most cases in Scotland and the north of England the married ploughmen live rent-free and rate-free in cottages on the farms on which they are employed, while the unmarried men and boys may live in bothies (see BOTHY SYSTEM). In other districts, particularly in the north-east and south-west of Scotland, there is a great want of cottages for the married ploughmen, so that practically all the regular farm labourers are boarded in the farmer's kitchen, and have sleeping accommodation provided for them in one or other of the farm buildings. This system is bad for the morals and general comfort of the married men. In the south of England, on the other hand, the farm labourers live mostly in cottages which they rent in the neighbouring villages, so that they may often have to walk one or two, or even three miles to their work. This plan ensures that their families will not have far to walk to school, whereas the children of the married men who live in cottages on the farms may have to go long distances to school. The south of England labourer sets great store on the fact that by living in the villages his children have not far to walk to school; but in Scotland and the north of England the labourer greatly prefers a cottage on the farm where he is employed, and he is not so much concerned about the distance that his family may have to walk in order to attend school.

The hours of labour also vary greatly. In Scotland the usual hours are 'from six till six', with one and a half to two hours off in the middle of the day for dinner. Of course the ploughmen's horses have to be fed an hour or so before they are yoked, and the ploughmen have to be in the stable an hour or so before yoking time to get their horses fed and the stable cleaned out, &c. In some districts, also, it is quite a common practice for the ploughmen to have to cut grass for the horses in the summertime before the regular work of the day commences, but this is not general. In some cases again, in wintertime the bulk of the threshing is done before the men can see to work in the field, but this also is not general. In the south of England, where the labourer lives in the village, which may be at some considerable distance from the farms where he is employed, the ploughman commences work at 7 a.m.; at midday he hangs a nosebag on his horses' heads, so that they may get a bite while he is having a sort of lunch which he has brought with him; and then he goes on till about 3 p.m., when he knocks off work altogether, and after feeding his horses he goes off home. Though his actual working day be shorter than that of the Scottish ploughman, the amount of work done in that time by the English ploughman is not so far short of that done by his Scottish rival.

The wages paid to farm labourers vary greatly in proportion to the importance of the use served by each, and the amount of skill or physical strength required for the different uses. The bailiff who represents his employer at fair or market, and is an inferior kind of steward, may have up to £100 a year, including the value of his perquisites; the grieve may have £60 to £80, with free house and garden; the shepherd and cattleman may have about as much, as their work goes on 'Sunday and Saturday' all the year round. In Scotland the ploughman's wages will average about £1 per week, excluding the value of his perquisites, such as free house and garden; the male outworker who has no horses to feed or attend to has a little less than the ploughmen, and female outworkers will earn from 1*s.* 9*d.* per day in winter up to 3*s.* per day in harvest. Dairy workers will earn from £20 to £25 per annum and 'all found'—*i.e.* with board, lodging, and washing,—while skilled butter and cheese makers will earn from £25 up to £50 a year and 'all found'. Where the farm labourer has a house and garden he will keep a pig and a few head of poultry, and these make a sensible difference to his revenue. In former times it was quite common for the farmer to allow any of his married labourers 'a cow's keep'—which was counted as being of the value of £10 to £12 per annum,—but in recent years the labourers' wives found that the milking of the cow constituted a rather heavy drag on them, and this plan has now been discontinued in large measure. Formerly, also, the great majority of engagements in Scotland were made on the footing of the men getting 'meal and milk'—½ boll of oatmeal per month and 1 pt. of milk per day,—but in recent years the farm labourers have shown a decided preference for 'money for all'. 'The halesome parritch, chief of Scotia's food', as Burns called it, is not by any means the 'chief of Scotia's food' now, so far as the farm labourers are concerned, as the grocer's van and the butcher's van supply the most of the food required by the farm labourer and his family. In the south of England, where the farm labourers mostly live in villages, the wages range from 13*s.* to 15*s.* per week, with 3*s.* to 4*s.* extra in haytime and harvest, and an allowance of beer or cider. The farm labourers are not so well paid in the south of England as they are in Scotland; but those who have had experience of farming in both countries say that the cost of farm labour is quite as high in the south of England as it is in Scotland or the north of England.

It has been often said that the farm labourer is the best paid of all unskilled labourers, as with a rent-free and rate-free house in the country £1 a week will go as far as 25*s.* a week will go in the towns. The latter part of this statement is about right, but the former part is distinctly incorrect, as the farm labourer is anything but an unskilled labourer. If anyone thinks that

the farm labourer is an unskilled workman he should get a band of townsmen who have never been at country work and set them to 'feer' and plough a field, or even to hoe a row of turnips, and he will very soon change his opinion.

A great many farm labourers have fully realized the importance of giving their families a good education, and many of the most noted men who have won for themselves fame and fortune were reared in the cottages of farm labourers. In recent years quite a number of prominent teachers of agricultural science have been the sons of farm labourers.

The prospects of the farm labourers are by no means all that could be desired. Everyone may know how hard it is to maintain a wife and young family on £1 a week or even less. Of course an unmarried labourer of a thrifty and ambitious character can save a considerable proportion of his wages; and many instances are well known where a farm labourer, with the aid of an active and thrifty wife, has secured the tenancy of a small farm, which served as the stepping-stone from which they were able to secure a larger farm. In fact, some men who began life as farm labourers have, through their own enterprise and frugality, risen to be extensive and highly successful farmers. Such men, however, are exceptions to the general rule. By way of encouraging the farm labourer to be thrifty and industrious, an Act has been passed for the creation of small holdings in England—and a similar Act will doubtless soon be passed for Scotland—so that the farm labourer may have something to look forward to in his declining years, instead of being forced, when he becomes unfit for his hard work, to crowd into the towns. As a matter of fact, in the south of England, where the wages of the farm labourers are lower than they are in Scotland or the north of England, the rural depopulation is so intense that very few except the older men remain as workers on the land, all the younger men and women having deserted the country and gone to the towns, or to Canada and other countries where 'free farms' of virgin soil can be had for the taking up, and where improved farms can be bought outright at the cost of a year's rent for similar farms in this country. It is true that under the Old Age Pensions scheme the farm labourer becomes eligible for a pension when he reaches the age of seventy, but that is not much to look forward to. [D. Y.]

2. The Training of the Labourer.—Among the many problems now engaging the attention of persons interested in the prosperity of rural districts, perhaps there is none of more importance at the present time than the provision of some form of education and training suited to the requirements of the labourer, and particularly the agricultural labourer. In moving about the country one is continually met on all sides with complaints from farmers of the difficulty of obtaining skilled labour; and the statement is frequently made that the skill and handiness possessed by the old labourers of former years is not to be found among the rising generation, owing to the bookish form of instruction which has been adopted in our elementary schools during the last quarter of a century. Under this system the boys, instead of being taught to use their hands, which most of them will have to learn in after-life, are given false hopes of obtaining employment as clerks or in other capacities in the towns. It is fully recognized, however, by those who are competent to judge, that quite as much skill and intelligence is required in these days on the land as in the workshop; and that a technical knowledge of his everyday work is as essential to the man who is engaged on the farm, and who often has to control the forces of nature, as to the artisan who works in the town chiefly with the aid of mechanical contrivances.

It may be said with confidence that a young labourer who has equipped himself with the latest information, and who takes a pride in his work, whether it be with horses, cattle, sheep, or in other general branches of farm work, would never lack employment, and farmers would only be too pleased to obtain the services of a good man they could rely on. Such a young man, too, would very naturally be imbued with some ambition, hoping in time to rise to the post of farm foreman, or even bailiff. This is as it should be, and would act as an inducement for him to do his best, and to give satisfaction to his employer.

We will now consider shortly what steps may be taken to train a young labourer of the type required, so as to develop in him some of those qualities which at the present time are so rapidly being lost. The only way is to make the teaching in our elementary schools of a more practical nature; and in this endeavour the sympathy and co-operation of the schoolmaster, as well as of people of influence in the immediate neighbourhood, must be obtained. Quite recently manual training, such as school gardening, has been introduced into the elementary school curriculum in many counties, with the most excellent results. This is not sufficient in itself, however. The spirit of enquiry and interest thus aroused in the scholars in matters surrounding their everyday life must not be lost as soon as the boy leaves school; but it must be fostered and encouraged as the boy gets older, and used as a basis for acquiring further information with the object of developing his skill in manual operations and rural crafts.

There are two courses which seem feasible for obtaining the end in view: one is the much-needed formation of higher elementary or rural craft schools in country districts on similar lines to some of the craft schools which have been conducted with such good results in certain industrial centres. It would be impossible to expect every elementary school to offer such facilities, but schools of this description might be formed to answer the purpose of a district, and to which pupils who are to follow agriculture might be drafted at the age of eleven or twelve from the neighbouring schools.

At such a craft school a certain amount of time would be devoted to literary subjects, such as reading, writing, and arithmetic; but they would be taught with a view to future useful-

ness, and the calculations, &c., would deal with matters likely to enter into the after-life of the pupils, such as the ordinary estimates, measurements, &c., used on the farm. Simple scientific principles dealing with plants, soils, manures, animals, &c., suitably illustrated by the phenomena of everyday life in the country, would also be introduced. The rest of the time would be devoted to manual work, such as constructive carpentry, gardening, and the care of farm machinery. Instruction in the more technical subjects, such as hedging and ditching, thatching, ploughing, dairy work, &c., might also be profitably worked in at the same time.

An alternative to the rural craft school which is now being adopted in some counties with the support of the Board of Education is the organization of continuous rural evening-school courses. In this case the boys on leaving the day school are induced to join an evening-school class of a preparatory nature, which gradually develops into a technical course in the second and third and subsequent winters. The objects to be obtained are similar to those in the agricultural craft school, viz.: the turning out of lads equipped with information likely to be of use to them in after-life, and to increase their wage-earning capacity.

By the adoption and careful working out of either of these systems, aided by the proper spirit of local co-operation, especially among farmers, it is to be hoped that the technical skill and handiness of their forefathers may be developed in the rising generation of our young labourers, and that this may be further supplemented by powers of thinking and observing for themselves which were lacking in the older type.

In conclusion, it may be said that there is little doubt that farmers, when they saw that such a system was producing the class of young man they required for the working of their holdings, would be willing to assist in every way, and try and arrange the hours of labour for the lads so as to fit in with any courses of instruction of which they might wish to avail themselves. [D. T.]

Labour on the Farm.—Labour in the first instance was manual in its nature, although at an early period animals were employed, as is shown by ancient monuments, tapestries, and frescoes. Appliances multiply the powers of the human body or hand, and become subservient to the workers in countless ways. It is difficult to separate all the ramifications of labour in the modern sense, but, as items of cost and of economy, the developments of mechanism cannot be disregarded. The expression 'labour-saving' includes all the methods of intensifying and compressing labour, as when a hay tedder does the work of eighteen men, or a self-binder of probably about the same number. Thus labour and mechanism are correlated, and it is impossible to approach the subject of agricultural labour without an appreciation of tools, implements, and machines, as well as of various descriptions of 'power'. To consider the subject of labour in all its branches, and to compare the economic advantages of manual work and mechanical force, of horse and steam power, or of wind, water, steam, and electricity, would be an ambitious task, and is not the object of the present article. In a work of this encyclopædic character these subjects are dealt with under special headings (see art. MOTIVE POWERS IN AGRICULTURE), and all that is intended in the following pages is to lay before readers a comprehensive view of the labour of the farm, which, in the first place, is divisible into mechanical and manual, and in dealing with their main divisions it is necessary to keep the many aspects of each steadily in view. While doing so, it is unnecessary to enter into abstruse calculations or problems, such matters being repugnant to the farming mind, which is eminently practical, and desires to arrive at the cheapest, most effective, and simplest method. As the lever is one of the most universal means of exerting force, all tools which bring powerful leverage to bear on their objects strengthen the hands of the labourer, and any saving in actual weight, whether of hand tools or horse implements, is so much gain to muscular strength. Tools must be well-balanced, light, strong, and efficient, and, armed with such instruments, a labourer may more than double his daily output. It is the same with horse-power, for well-constructed implements may be drawn by two horses instead of by four, and consequently influence the number of horses necessary to work a farm. Steam-power affects both manual and horse labour, for with its assistance many kinds of work can be accomplished with great rapidity which, without it, would require a larger expenditure of both. Water and wind are employed upon farms with the same objects, and their use is to be recommended. Still, they may be regarded rather as occasional than usual, and the principal kinds of power on farms are manual, horse, and steam. We shall therefore discuss them in some detail, but with as much brevity as possible.

Manual labour is superior to any application of unconscious power, on account of its intelligence, as shown in selection, variation in force, delicacy of touch, and adaptation to every minute difference in the material acted upon. No form of labour beats 'hand labour', as is illustrated by the higher price given for hand-made goods. The same is true in the field, for no machine can rival hand reaping, mowing, hoeing, digging, and many other descriptions of work. As a competitor with machinery, hand labour possesses points which commend it to a large class of practical farmers. It gives 'employment', which cannot be said to be directly the case with machinery. If it is more expensive it, as already mentioned, is often superior. Calculations are liable to be misleading as regards the relative cost of machine and hand work. Take sheep-shearing as an example, or 'loaders' for securing hay. In both these cases the machines are only required for a very limited time during each year, and in too many cases become rusty, foul, stiff, and old-fashioned in the interim. In this case a mere comparison of the cost of clipping 100 sheep by hand and by machine is not sound. On the other

hand, a shepherd with helpers would clip his flock at very little extra cost, if any, as he is in regular employment on the farm. In the case of 'loaders', men must feed and attend them, and the rate of deterioration cannot be placed at much less than 20 per cent per annum. This, with repairs and interest, will amount to at least £5 per annum, and this is the true cost of the implement. A couple of good pitchers at 5*s.* a day would clear 100 ac. in, say, eight days, at a cost of £4. This would beat the machine even if it could do its work without man's help, so that the calculation in this case seems to be in favour of manual labour. Neither must we forget the human side; for men, who work at comparatively low wages from October to April, should not be grudged higher earnings from May to September; and it is a question of importance whether the displacement of hand labour by machinery may not tend to raise what are called 'winter wages', which in themselves are scarcely sufficient to maintain a family. The summer work is looked forward to by good men to make up an average fair wage during the entire year. It is therefore well to pause before substituting machines, when men are available and wages are not too high. Where such conditions do not exist, the argument fails; but there are countless cases in which large farmers find it best to keep their men in good employment in summer, even if the actual cost might be reduced by machines.

There is another point which is often brought very distinctly before the attention of masters. It is when crops are so twisted and storm-tossed that machines cannot cope with them. It is scarcely to be wondered at that, in such cases, an exorbitant price should be asked by men; and their excuse is, that they are called upon to help out a machine which is robbing them of all the 'straightforward' work. In grass, the heaviest part lies nearest the ground, and as a scythe will cut deeper than a machine, mowing may make a difference of 2 or 3 cwt. of hay per acre, or of from 6*s.* to 9*s.* This is an argument in favour of hand-mowing which would never occur to a mechanician in stating the relative costs of hand and machine work. Considerations such as this are well worthy of the closest attention, and are extremely liable to be overlooked.

Lastly, it may be well to add a few words upon the large amount of capital absorbed by implements if a taste for novelties is indulged; and if it is, there is positively no end to the outlay. It is easy to draw up a list of the necessary implements required on a farm; but if, after doing so, the mind is allowed to wander, as it were, through the long ranges of labour-saving machines seen at shows, purchases apparently justifiable in themselves would soon absorb almost all the money available for stocking a farm. The following important questions demand an answer. Will the purchase of a particular machine really reduce the total labour bill of the year? Will it enable the purchaser to dispense with a man or a boy? Will it not be more likely to merely save a certain amount of trouble by lightening labour, without reducing the weekly paysheet? If not, it is a questionable advantage. The deterioration of implements by simple supersession is far greater than wear and tear, and after paying for unnecessary implements, a heavy discount, after a year's wear and tear, must be faced. It must not be thought that the author of this article is biased against implements, for such is not the case; all he desires is to guard readers against purchasing unnecessary machinery.

Horse Labour

Horses maintain their position on farms in a manner which may, at first, cause surprise. They have been displaced in so many other directions that it might appear as though farmers are mistaken in retaining them, and not adopting steam cultivation and steam haulage. The explanation lies in the fact that horses are cheaper than steam, on the land. Wherever steam is truly economical it has been adopted by farmers, as for example in threshing, grinding, cake-breaking, and chaff-cutting. Horses, however, still hold possession of *the field*, simply because they cannot, as yet, be displaced by anything better and more truly economical. It is difficult to believe that practical agriculturists would continue to plough with horses if they were not cheaper than steam, and we conclude that such must be the case. Engines and 'tackle' are placed at great disadvantage when they have to contend against the elements in the open field. Farm roads are often impassable, and the fields soft and miry. Machinery worth many hundreds of pounds is most unfortunately placed in circumstances which do not in the least interfere with the wellbeing of horses. These can be used, or put into the stable until wanted again. They may be yoked singly or together, and may be growing into money. A steam engine cannot be so used. It is infinitely less versatile, and getting up steam is expensive and troublesome. Depreciation in value is a serious item, and adds materially to the costs of working. The cost of maintaining a horse is probably much less than it is usually estimated at, because summer grazing, green food, straw, roots, corn, and hay are all produced on the farm, and are to some extent returned in the form of manure. If these items were valued at the cost of production they would be priced considerably below market value, if only because the food supplied is not of the most marketable character. This may be open to objection on the ground that the best fodder only should be used for working horses. If, however, we take ordinary practice as a guide, we find that horses are fed with the lighter and worse-coloured oats, and that a second quality of hay is thought good enough for them. To estimate the cost of keeping a farm horse in terms of oats and hay at London prices is manifestly incorrect, and yet even by so doing it is difficult to work up an estimate to over £25 per annum for each horse.

Detailed Estimate of Cost of Horses.—In order to substantiate this general estimate, we place before readers a more detailed one. Presuming

that an average farm horse is worth £40 at six years old, and £20 at sixteen, his deterioration is only at the rate of £2 per annum. The incidental expenses upon farm horses are as follows: (1) shoeing and blacksmith work, which in many cases include repairs of ploughs, harrows, and wagons; (2) harness; (3) repairs of stables; (4) litter; (5) veterinary attendance; (6) risks from death and accident; (7) depreciation and interest. The wages of the teamsmen should not be included as a charge in horse maintenance, because if it is, it will be liable to appear twice—first as an integral part of the cost of keeping horses, and secondly, as an item on the paysheet. This is a point of importance, because in discarding horses in favour of steam cultivation both classes of expenses are saved; and the late John Algernon Clarke, in his elaborate paper upon 'Steam Cultivation', contributed in 1867 to the Royal Agricultural Society's Journal (vol. iii, 2nd series), went minutely into the cost of horse maintenance, quoting many excellent authorities. The conclusion arrived at was that, in parting with a horse in favour of steam-power, a saving of £41 per annum is effected; and Mr. Morton estimated the same at £46, out of which £14, 8*s*. was due to teamsmen's wages.

Since the 'sixties a considerable reduction in the cost of horse maintenance has taken place, owing to depreciation in the value of fodder; and this is made plain by the following estimate from Morton's Handbook of Farm Labour:—

Estimate, 1868

	£	*s.*	*d.*
2 tons of hay at feeding value ...	6	0	0
7 ,, green food at 20*s*.	7	0	0
9 qr. of oats at 24*s*.	10	16	0
1 ,, beans at 36*s*.	1	16	0
Straw and chaff	1	10	0
	27	2	0

In the same excellent work no fewer than 115 dietaries are tabulated, and, notwithstanding the high prices of 1868, the average cost of summer food is given as 8*s*. per week; of autumn food, 9*s*. 6*d*. per week; of winter feeding, 6*s*. 4*d*. per week; and of spring feeding nearly 10*s*. a week. The average of all these cases, over the entire year, for food, works out at 8*s*. 5½*d*. per week, or £22 per annum, which is considerably less than the above schedule. The cost of horse food is now much less, for such oats as horses generally receive are highly valued at 16*s*. per quarter; and the feeding value of home-grown hay is not more than 50*s*. Eight shillings per quarter on 9 qr., or £3, 12*s*., is at once saved, and £1 on the hay. The beans are accountable for £1, 16*s*., which might readily be dispensed with, thus saving £6, 8*s*. upon this estimate. As to the allowance of hay, 2 tons per annum is too much, for during twenty weeks in summer horses scarcely touch it, and in slack times, during winter, straw should be given. One 56-lb. truss per week for thirty weeks, or 15 cwt., is not unreasonable, and the night grazing in summer is not an equivalent as to cost. We should therefore be inclined to substitute, at most, 1 ton of hay at 50*s*. for 2 tons at 60*s*., and these deductions bring the cost of food down to £18, 4*s*. per head per annum. In a paper contributed by the present writer upon bedrock costs of tillage (1906), a careful estimate was given both as to food and maintenance of farm horses, which he takes the liberty to subjoin:—

		£	*s.*	*d.*
104 bus. of oats at 2*s*.		10	8	0
15 cwt. of hay at 2*s*. 6*d*.		1	17	6
22 weeks night grazing at 1*s*. 6*d*. ...	3*s*. per week	3	6	0
22 weeks cut fodder at 1*s*. 6*d*.				
Chaff		1	0	0
Roots		1	0	0
Total food		17	11	6
Litter may be sunk as being returned to the land with the manurial residues of oats, hay, and other foods.				
Shoeing and blacksmith work divided over all the horses		2	0	0
Harness		1	10	0
Stable utensils and repairs to mangers, &c.		0	10	0
Veterinary attendance		0	10	0
Depreciation on a value of £45 at six years old		2	10	0
Risk 10 per cent on an average value of £30		3	0	0
Total cost		27	11	6

Having made a liberal estimate, it is only fair to check it over, and in doing so it may be noticed that £5, 10*s*. is a high rate for insurance and interest per annum; that £45 is above the average value of farm horses; that 2 bus. of oats all the year round is unnecessary, and that 1½ bus. is nearer the mark. From the total, £2, 11*s*. 6*d*. may easily be written off as excessive, and it does not appear to the writer that there can be any counterclaim for increasing any other item. In the above schedule, blacksmith's work is charged against each horse, and is meant to cover all but new work.

Cost of Horse Labour per Day.—In order to reduce the annual expenditure of cost per day, it is usual to assume that horses work 300 days during the year. But in the case of clay land this may be over-sanguine. Suitable work will, however, generally be found even when the land is too wet for tillage, and it should also be remembered that, during summer, horses often work very long hours. However this may be, it is clear that £25 divided by 300 is 1*s*. 8*d*.

Cost of Horse Labour in Summer and Winter.—If we are satisfied that the actual cost of maintenance of a farm horse *per se* is £25 per annum, or 1*s*. 8*d*. per working day throughout the year, there ought to be some adjustment of the charges between summer and winter. It is unreasonable to charge horses 1*s*. 8*d*. per day when they are engaged in important work, such as harvesting or drilling. Much work of similar class is undoubtedly done in winter, but there is a broad difference between the value of work performed from April to September, and between October and March. It is therefore suggested that the total cost should be divided, for certain purposes, between these two periods; and there is no objection to charging 2*s*. 6*d*. per day during the more active part of the year,

provided the sum of £25 is not exceeded. The calculation, upon this basis, works out as follows:—

	£	s.	d.
150 days in summer at 2s. 6d. ...	18	15	0
150 days in winter at 10d.	6	5	0
Total	25	0	0

The conclusion is logical, but the figures may be differently adjusted, and there can be no objection to charging horses 2s. 6d. in summer and 1s. in winter. The only consequence is that the total annual charge is raised to £26, 5s. instead of £25, which is well within the variations of fair estimates. The advantage of this method of computing horse labour is, that the lower cost for the dark days of winter, for dung carting, odd jobs, and short hours, reduces the estimated cost of such operations. It is a serious matter for reflection if horses at such work are considered to be costing 2s. 6d. per day each, and gives rise to the feeling that the work is not worth doing. If, however, the view is taken that the horses earn the greater part of their cost of maintenance during the summer half of the year, the cost of work of the class referred to is seen to be reasonable. The fallacy of charging horses 2s. 6d. per day all the year round (unless the wages of the teamsmen are included) is evident, because it means an annual cost of £37, 10s. per horse, which is beyond any reasonable estimate. The actual cost of farming operations is in this way exaggerated, and the costs of cultivation so raised that no profit is discernible. The farmer, in fact, becomes a haulier, making a profit upon his horses, and losing upon his crops.

Value, Price, and Cost.—It is necessary, in order to arrive at a clear idea of the *cost* of horse labour, to keep both the value and price of horse labour distinct from it. The value of the labour may be incalculable in some cases, but the cost is not thereby altered. Or, the price for hiring or letting out a horse may be 5s. a day, but this does not influence the cost, any more than the price of a pair of boots reflects the cost of the manufacture.

Valuation of Tillages

Valuations of tillages are acknowledged to be in many cases excessive, but it is not necessary to assume that they are meant to represent actual cost prices. An outgoing tenant ought to make a profit when ploughing for his successor; and we are not prepared to quarrel with the awards of valuers, especially as the incomer may reasonably hope to have his own tillages valued upon the same scale when he leaves his farm. We have here to consider the actual cost of tillages done by a farmer for his own advantage. If we can arrive at the cost of ploughing, it will be less difficult to ascertain that of harrowing, rolling, and other tillages, upon the same principle.

Cost of Ploughing.—The actual cost of ploughing depends upon the number of horses required, the amount ploughed in the day, and the strength of the land, all of which factors vary considerably. Although two-horse teams are common, stubbles often need three, and the stiffest classes of clay require four horses. The amount ploughed varies from ½ ac. with four horses, to 2 ac. with a pair team—as is undoubtedly done on certain light soils. The width of the furrow is of great importance, as it varies from 9 to 12 in. There is an enormous difference between ploughing loose land with a foot-wide furrow, and unbroken stiff land with a 9-in. furrow. The extremes may be illustrated as follows:—

4 horses, including men and implement, at 2s. 6d. = 10s. per day and £1 per acre if ½ ac. is ploughed.

2 horses, including men and implement, at 2s. 6d. = 5s. per day and 2s. 6d. per acre if 2 ac. are ploughed.

These may appear to be extreme cases; but with reference to the first, Kentish farmers have expressed willingness to pay £1 per acre for steam ploughing, on the ground that they cannot plough it with horses for the money. As to the second, the late Mr. Angas of Neswick assured the writer that a lad and a pair of horses could plough 2 ac. of light chalky land on the Yorkshire wolds. Also, the late Mr. James Howard of Bedford, in a paper read before the London Farmers' Club on 'Things in America', stated that an American farmer expects from 2 to 2½ ac. to be ploughed in a day!

The standard for ploughing is 1 ac. per day for a man and two horses, and this ought to be realized on an average, taking all sorts of ploughing into consideration. It is true that ¾ ac. is not a bad day's work on ordinary stubble or lea land; but 'stirring' land a second or third time, with a foot-wide furrow, at a quick pace, ought to be done at the rate of 1¼ ac. per day. We therefore take 1 ac. *per diem* as our standard. The cost works out as follows:—

	s	d.
2 horses at 1s. 8d. (including keeping up plough)	3	4
Ploughman or ploughboy (average) ...	2	2
Total cost per day and per acre	5	6

If, however, ¾ ac. only is ploughed, the cost will be 7s. 4d. per acre. Again, if three or four horses are required, the cost will be—

	With 3 horses.			With 4 horses.	
	s.	d.		s.	d.
Horses	5	0	......	6	8
Ploughman or boy ...	2	2	......	2	2
Man or boy to help ...	—		......	2	2
Per day ...	7	2		11	0

If, as is likely, ¾ ac. is ploughed:

	s.	d.	s.	d.
Cost per acre	9	6	14	8

It is not therefore difficult to see that under certain circumstances ploughing may cost either 5s., 10s., or 20s. per acre.

Double and Triple Ploughs.—The introduction of double- and triple-furrow ploughs of light construction has done much to cheapen plough-

ing. These implements have been brought to great perfection of late years, and cost little more than ordinary single ploughs. The double-furrow plough is easily drawn by three horses abreast, which walk equally fast as when yoked to single ploughs in pairs. This is equal to a reduction of one horse on two furrows, or a reduction of one quarter of the horse labour, besides saving a ploughman. In some cases a good team of two horses can draw a double-furrow plough, and the case of triple-furrow ploughs drawn by three or four horses is also worthy of consideration. Two double-furrow ploughs have been observed by the author to complete a 'bout' of 620 yd. in length in twenty-five minutes, *i.e.* to turn 8, 9-in. furrows, or 2 yd. wide and 620 yd. long, in that time. This is 1240 sq. yd., or a fraction over $\frac{1}{4}$ ac. every complete turn. This observation was taken without the knowledge of the men, and fairly represented their pace. Assuming eight hours as a fair day's ploughing, then six horses and two men were ploughing unbroken stubble, and land of average strength, at the rate of at least $4\frac{4}{5}$ ac., and more correctly 5 ac. a day. According to a standard of 1 ac. for every two-horse team, it would have needed ten horses and five men or lads to do this work, so that there was, in this case, an apparent saving of four horses and three men. This shows the great saving which may be accomplished by good and modern implements, and in this connection may be mentioned the saving effected by two-horse drills, one-horse, half-harrows, wide horse-rakes and broadcast machines, hay tedders, hay sweeps, &c.

Cost of other Tillages.—Harrowing is usually estimated at 6*d.* to 7*d.* per acre, but the actual cost of two-horse harrowing, supposing 16 ac. to be singled in the day, would be $\frac{5s.\ 6d.}{16}$, or $4\frac{1}{8}d.$ per acre. Four-horse harrowing is naturally slower, but taking the same area as accomplished per day it would cost $8\frac{1}{4}d.$ per acre.

The amount of work done in other cultivations is arrived at as follows: For every 9 in. in width taken by any implements, at ordinary plough pace, 1 ac. of ground will be covered per day. The pace varies no doubt, but on this assumption a drill or broadcaster 7 ft. 6 in. wide should cover 10 ac. If drawn by one horse and attended by one man or boy, it would cost 3*s.* 10*d.* per day and 4·6*d.* per acre. If drawn by two horses and attended by one man, it would cost 5*s.* 6*d.* per day and 6·6*d.* per acre. Similarly, with three horses, 7*s.* 2*d.* per day and 8·6*d.* per acre. Or with four horses and one man, 8*s.* 10*d.* per day and 10·6*d.* per acre. This rule would apply to 'cultivators' if drawn at plough pace, but would require an addition to the estimate if the pace were slower. Thus, a cultivator 3 ft. wide would only accomplish 4 ac. per day, and if drawn by four horses would cost $\frac{8{\cdot}10}{4}$ or $2{\cdot}2\frac{1}{2}d.$ per acre; but if six horses were necessary it would cost 12*s.* 2*d.* per day and about 3*s.* per acre.

Carting is more difficult to estimate, as so much depends upon distance, but it may be determined by taking into account the number of horses, men, and lads required in any particular class of haulage (see 'Cost of Wheat Growing').

Cost per acre of Horse Labour.—If we take an average case of one two-horse team for 60 ac. of land where there is a fair proportion of arable and pasture ground (say two-thirds arable), it is evident that the horses (see p. 228) will cost one-sixtieth part of £50, or 16*s.* 8*d.* per acre. It has sometimes been computed on a basis of £60 as the cost of maintenance of two horses, in which case it would be exactly £1 per acre, and this is not a bad guide. At all events we may conclude that the actual outlay on horse labour on farms of an ordinary class will be from 15*s.* to 20*s.* per acre. The capital required for farm horses is easily estimated by assuming the value of farm horses to be £30 each, in which case the capital required would also be £1 per acre, in providing teams for working the farm.

If we wish to arrive at the actual cost of growing a crop, we must adopt some reasonable method of arriving at the costs of horse labour, such as the figures above given, feeling that if we adopted the prices used in valuations we should run up a bill of costs which no ordinary corn or root crop could stand.

Manual Labour

Amount of Manual Labour Required on Farms.—This is a very wide subject, as the differences in the character of the land and of the cultivations followed are extraordinary. The proportion of grass to arable land is one of the most important of these differences; but the rotation practised, the length of time grass is allowed to lie, the cultivation of hops or fruit, the head of stock kept, the maintenance of a large dairy of cows, as against dry stock, &c., all show the difficulty of forming any general estimate of the cost of manual labour. Under this head all teamsmen's wages must be included, because they appear upon the weekly or fortnightly paysheet, and this at once disposes of the erroneous system of adding this cost to that of the horses unless a corresponding deduction is made from the manual-labour bill.

The total manual labour on farms worked upon a four-course system has often been assumed as 30*s.* per acre, and on large mixed farms it is difficult to keep it below 27*s.* 6*d.* In some cases, by rigid economy, it may be reduced to 25*s.* per acre, but, on the other hand, hop and fruit growers, or those who cultivate potatoes on a large scale, find that twice 30*s.* does not cover the outlay. We cannot place any limits upon the profitable employment of labour, and may join with the wise man in saying that 'In all labour there is profit'. It is reduced to the lowest ebb on grazing farms, and raised to high-water mark on fruit farms and hop yards; but we have to keep in view ordinary farming, with its accompaniments of corn, sheep, and cattle, with possibly a few acres of potatoes. On such farms the earlier given figures will be found fairly applicable. It is a question how far the farmer's time should be considered as an item of labour.

But we can scarcely admit that this is necessary. A good foreman ought to be available for 25*s.* to 30*s.* a week (inclusive), and if worthy of his place he may perform the work better than the master, as he is always about, and is intimately acquainted with every detail. He will save his wages many times over, and the charge of such a man is, after all, only 2*s.* per acre on a 650-ac. farm. He may be dispensed with by a working farmer, but on large holdings occupied by capitalists he is indispensable. His place may be filled by a 'leading man', who acts during his master's absence; but the difference is trifling, and it is on the whole better that he should possess some power, and the consciousness of responsibility. His wages are saved not only by organizing the labour, but in looking after the wellbeing of the live stock, and the care of the implements and stores. We shall therefore regard him as the farmer's assistant rather than as contributing to swell the expenses.

Classification of Labourers. — On large and well-equipped farms there is always a permanent staff of men, and also a varying number of ordinary farm labourers and 'strappers'. The paysheet during the height of summer may contain one-third more names than it does in winter, but the number is less than it used to be before the time of the self-binder and other labour-saving implements. The following classes of men all occupy responsible positions, and ought not to require to be constantly instructed as to the details of their work:—

The *foreman,* farm bailiff, or grieve (see above).

The *head carter*, hind, or teamsman, takes charge of a team, and in some cases of six or eight horses, with an under carter and helpers. In other districts each 'hind' looks after and works a pair of horses.

The *cattleman,* or dairyman, attends to the stock, including pigs and poultry, and is held responsible for the calving and milking of cows, the making of butter and cheese, and the delivery of milk, and he also keeps a record of all petty sales, rendered once a fortnight.

The *shepherd* only attends to the sheep on large farms, but on smaller holdings he may act as foreman, or in some other capacity.

The *engine driver* will probably be the foreman.

The *barnman,* if the office is separately held, looks after the winnowing, screening, and weighing up of corn, attends to the sacks during threshing, and, when not so engaged, may thatch, cut hedges, and do other descriptions of work.

The *meadow* or *mead man* is only found where there are water meadows, but he then holds an important post, as he regulates the watering or 'drowning' of the meadows, and keeps the watercourses in order, levels the ground after it has been trampled by cattle, helps to mow the grass to make the hay, and assists in harvesting and threshing, when not required on the water meadows.

Milkers assist, and are under, the dairyman while milking. They are provided at the rate of one to ten or twelve cows, the dairyman taking his place as one. After milking is over, which only occupies about one hour twice a day, they are available for other descriptions of work.

The *groom* or stableman may attend exclusively to the saddle horses, or may act as gardener and useful man, but even in less ambitious homesteads he is necessary to look after the horse or horses, traps and harness, &c.

Labourers are employed throughout the year, and in busy times. They have little responsibility, and, except in periods of pressure, such as haytime and harvest, ought not to be numerous. They must, however, be skilful, and willing to do any kind of work.

Female labour is largely employed in Scotland and the north of England, but not nearly so much in the southern counties. Where women are regularly employed, and dress suitably for their work, they are extremely useful, and cheaper than men. They are excellent milkers, hoers, haymakers, weeders, winnowers, sack menders, &c., and in some cases assist in feeding bullocks. They are usually employed in bands or parties, and are led by one experienced man. They are well suited for sorting and 'snubbing' potatoes at the heap, and can be employed in many other ways. A good band of women workers does much to reduce the cost of labour, and is one of the causes why Scottish farmers, although paying their men higher wages than are paid in the south, can keep their labour costs down to a low figure—often little above £1 per acre.

Actual Number of Labourers.—So far as ordinary extensive farming is concerned, we are now in a position to gauge the number of people required on a 500- or 1000-ac. farm. It is impossible to go into details as to the number of labourers needed for small holdings, as there can be no classification, and the entire work may be

		£	*s.*	*d.*
	1 foreman at 25*s.* a week inclusive ...	65	0	0
4 in each stable.	2 head carters, in two separate 8-horse stables, at 18*s.* ...	93	12	0
	2 under carters (one for each head carter) at 14*s.* ...	72	16	0
	2 third carters at 10*s.* ...	52	0	0
	2 boy helpers at 8*s.* ...	41	12	0
	1 shepherd at 18*s.*, including perquisites ...	46	16	0
	1 under shepherd at 14*s.* ...	36	8	0
	1 shepherd's boy at 10*s.* ...	26	0	0
	1 dairyman at 25*s.* (including egg money, &c.) ...	65	0	0
	4 milkers (also employed on the farm) at 12*s.* ...	124	16	0
	1 pony boy (always useful) at 9*s.* ...	23	8	0
	1 thatcher, water-meadow man, hedger, and barnman, 18*s.* ...	46	16	0
	1 groom and useful man, 15*s.* ...	39	0	0
	3 to 9 ordinary farm labourers at 15*s.* (average wages); say 6 at 15*s.* ...	234	0	0
Total,	23 to 29, according to the season ...	967	4	0

done by the farmer and his family. On large farms the above classes of skilled men will, or may, be all represented, and the number of 'labourers' will alone vary. In such cases it is easy to make a list with costs, so far as the 'staff' is concerned, and when once the chief offices are filled, the ordinary labourers can be added. If, therefore, we take a good-sized farm of, say, 700 ac., in which 550 ac. are arable and 150 ac. are in pastures and meadows, the number of men required is shown on p. 231. This works out to £1, 7*s.* 7½*d.* per acre over the entire area of 700 ac., which agrees well with the previous general statement.

Circumstances Affecting the Number of Labourers.—The tendency during late years has been to reduce the number of hands employed on farms, as may be readily shown by reference to the late Mr. Morton's Handbook of Farm Labour, published in 1868. No more concentrated manual on the subject has ever appeared, but his examples are antiquated and read strangely in the light of recent times. It would be useless to quote his figures at length, although they are based upon a large number of farms of light, medium, and stiff character. His data are tabulated and reduced to per acre terms; and, as showing the enormous differences in labour costs according to circumstances, the following synopsis is given:—

Class of Land.		Extent in Acres.				Horses worked.	Hand Labour.			Annual Labour Bill.	Wages per acre for Arable, deducting 5s. for Pasture.		Acres to each Pair of Horses.		
		Fallow Crops.	Grain.	Clover.	Pasture.		Men.	Women.	Boys & Girls.	£	s.	d.	Total Arable Land.	Land actually under Plough.	Land under Fallow Crops.
Light soils	1.	210	350	350	15	20	28	—	22	1383	30	0	90	56	20
	2.	235	515	150	120	29	30	12	15	1560	34	0	62	52	16
	3.	110	420	130	100	20	33	3	13	1260	37	0	66	53	11
Medium soils	1.	70	160	30	—	7	12	8	4	700	54	0	74	64	20
	2.	78	175	57	110	8	8	10	—	500?	32	0	78	63	19
	3.	50	125	25	100	7	14	4	5	450?	40	0	57	30	14
	4.	91	224	85	40	11	16	4	8	700	34	6	72	54	16
	5.	566	946	492	430	56	95	40	20	3200	32	0	71	53	10
	6.	60	174	174	280	12	25	12	8	750	34	0	68	40	10
Heavy soils	1.	20	80	12	70	3	7	—	4	250	42	0	74*	16	14
	2.	120	350	120	225	28	31	14	17	1170	38	0	42	33	9
	3.	120	280	120	200	20	34	7	12	1200	44	0	52*	40	12

*Much of the cultivation done by steam.

According to the above table, the amounts paid in wages on light soils vary from 30*s.* to 37*s.* per acre, on medium soils from 32*s.* to 54*s.*, and on heavy soils from 38*s.* to 44*s.* per acre. The cost of labour is much affected by the rotation followed, as is readily seen from the following statement:—

On the four-course rotation, clover lying 1 year, three-fourths is under the plough.
On the five-course rotation, clover lying 2 years, three-fifths is under the plough.
On the six-course rotation, clover lying 3 years, one-half is under the plough.

A large dairy entails probably as much labour on the grass area as on the tillage land, and it has been stated on good authority that no diminution of labour follows the laying of land away to grass for dairy purposes. It has also been stated that, over extensive areas of arable land, one man is required for every 50 ac., one extra man for every 100 ac., and as many boys as men. This is 6 mixed labourers per 100 ac.

In Example 1 of the above table, light land, there is a total of 910 ac. of arable and 50 hands; in Example 2, 900 ac. and 57 hands, but there are also 120 ac. of pasture which might easily absorb four to seven hands. In Example 4, medium soils, there is an area of 400 ac. of arable and 40 of pasture, and the total number of work-people employed is 28, or 7 to the 100 ac. When potatoes are largely grown, or other special cultivations are undertaken, the number of labourers per acre would be increased. Several of the examples supplied by Mr. Morton greatly exceed the above estimate, and all of them would probably be much reduced in our day, excepting when special cultivations are carried on. The current example, first given in detail, works out as 23 to 29 men and boys on 700 ac. of land, or about 3·5 to 4 per 100 ac., and yet this is a well-equipped farm, carrying a flock of 500 ewes and a dairy of 60 cows, besides young stock, pigs, and a large head of poultry.

A burden of 30*s.* to 40*s.* for manual labour could scarcely be borne at present prices, as horse labour is to be added, and the total labour bill, horse and manual, would amount to from 50*s.* to 60*s.* per acre. This is too large an amount when we remember that the total produce of large farms seldom exceeds £5 per acre over all. Rent, seed, purchased foods, manures, and many other charges would soon eat up this amount, if such large sums were needed for labour alone. Farmers have naturally endeavoured, while keeping up efficiency, to reduce labour, and this they have accomplished by altering cropping, and by the adoption of machinery, whenever possible.

Cost of Raising Crops

The next subject which demands attention is the actual cost of raising crops, based on data already supplied. The best method of dealing

with this difficult subject in a limited space is to follow out a four-course rotation of crops, in order to ascertain the total cost; and then to divide by four in order to arrive at the average annual cost. By this system we shall, by keeping all the labour items together, both horse and manual, arrive at the cost of labour per acre, always excepting labour directly expended upon live stock, and incidentals, which may be computed separately.

Cost of Producing a Crop of Wheat after Clover.—In this case the land should be dunged in early autumn, and may then be ploughed, pressed, sown, and harrowed; or ploughed, rolled, harrowed, and drilled. The cost of dunging depends upon the amount applied per acre, and the distance. It, and most carting operations on farms, has been computed at from 6*d.* to 1*s.* per ton per mile, but this is somewhat haphazard. The author finds no difficulty in letting the work of filling and spreading at 4*s.* 6*d.* per acre, *i.e.* for a dressing of 16 loads per acre. All that is left to calculate is the cost of the horses, and the teamsmen and boys employed. If we assume ¾ mile as a fair average distance for carting, four carts will be required, and as there may be a steep gradient on the road, we shall allow one trace horse, or five horses in all. There will be one man drawing out the dung in small heaps, and three boys leading. The expense is readily calculated as follows:—

	s.	d.
5 horses at 1*s.* 8*d.* per day[1]	8	4
1 man (head carter) drawing out dung into heaps	3	0
3 boys at 1*s.* 6*d.*	4	6
Cost of horses and teamsmen per day ...	15	10

The amount of land dunged in the day will be 4 ac. at 16 loads per acre. If three fillers are employed, this seems to be a moderate day's work, for at 1*d.* per load for filling, a man ought not to put up less than 24 loads per day. In Northumberland two men and a strong boy will fill 80 loads per day of short dung at the heap, but in the south of England three men will not fill more than 64 loads of long dung from a yard. Assuming 4 ac. to be the area dunged, and taking 16*s.* instead of 15*s.* 10*d.* as the cost, the team labour costs 4*s.* per ac., while filling and spreading cost 4*s.* 6*d.*, making the total cost of dunging 8*s.* 6*d.* per acre. If it is thought that 64 loads is too low an estimate of what three men on task work would do, the cost may be reduced, as a larger area will be dunged; so that we may conclude 8*s.* 6*d.* to be a full estimate.

Cost of Harvesting Wheat.—Old estimates are of little value in this case. The work begins with the self-binder, which will (see vol. lxvii, p. 103, 1906, Royal Agricultural Society's Journal) tie up wheat at from 4*s.* 3⅔*d.* to 5*s.* 8*d.* per acre according to the number of horses engaged and the area cut per day. Both estimates are moderate as to amount of work done, and therefore the actual cost is probably less than the above figures. We therefore take the estimate of 12 ac. cut by three horses (six engaged), at 4*s.* 8*d.* per acre. To this, 1*s.* per acre must be added for setting up in stook.

Cost of Carting Wheat.—In Morton's Handbook of Farm Labour, pitching and loading is estimated as costing 1*s.* per acre. If we take the case of two pitchers to a wagon, at 5*s.* per day, and two loaders on the wagon at 3*s.* per day, and further assume that they clear 16 ac. of a good crop at a cost of 16*s.*, it agrees with Morton's estimate. Stacking is best done in the field, and three wagons with five horses will be sufficient. These require the services of three boys at 2*s.* per day, and if we allow the horses in this case to be charged 2*s.* 6*d.* per day (simply because 1*s.* 8*d.* would be thought too low) we have—

	s.	d.		s.	d.
5 horses at 2*s.* 6*d.*	12	6	at 1*s.* 8*d.*	8	4
3 boys at 2*s.* ...	6	0	at 2*s.* ...	6	0
	18	6		14	4

This, applied to 16 ac., gives us sums of which the mean is also 1*s.* per acre. Rick building is estimated at 8*d.* by Morton, and thatching at from 1*s.* to 1*s.* 4*d.* per acre. The cost of harvesting a wheat crop therefore works out as follows:—

	s.	d.
Cutting and tying up with binder, including twine	4	8
Stooking	1	0
Pitching and loading	1	0
Rick building	0	8
Carrying	1	0
Thatching ... ... 1*s.* to	1	4
Total cost per acre	9	8

Cost of Harvesting Barley.—In the case of barley the cost is lightened, first by the smaller weight of the straw, but more particularly if the crop is carted loose. In this case the cost would be as follows:—

	s.	d.
Mowing by hand	4	0
Twice turning	2	0
Carting, &c.	3	0
	9	0

The cost of harvesting oats is the same as that of wheat.

The cost of threshing is arrived at as follows:—

	£	s.	d.
Hire of 8-horse-power engine and 'drum', with driver and feeder ...	1	15	0
Coals and oil	0	8	0
Water carting, half time of 1 man and horse	0	2	6
3 men pitching on rick	0	7	6
1 man attending to sacks	0	2	6
1 man and 2 horses removing corn ...	0	5	10
Use of straw elevator	0	5	0
2 men on straw rick	0	5	0
Labour on removing chaff, half time of 1 man	0	1	3
	3	12	7

If the engine and machine are part of the equipment of the farm, the use and wear and tear are often put at £1 per day, and the cost

[1] See previous calculation as to actual cost of maintaining farm horses *per se*, or less teamsmen's wages.

of the operation then works out to about £3 per day. If we accept this figure, the cost per quarter depends upon the number of sacks threshed, and if 50 qr. is taken to represent a fair day's work for wheat, $\frac{60}{50}$ = the cost per quarter, or 1*s.* 2½*d.* If 60 qr. are threshed, the cost is 1*s.* If 80 qr. are threshed, as is quite possible in the case of oats, the cost per quarter will be reduced to 9*d.*

Winnowing is often valued at 2*d.* per quarter, or 1*d.* per sack. The cost per acre is arrived at by multiplying the above figures by the number of quarters yielded, and on average crops it would be about as follows:—

Cost of Threshing, and once Winnowing

		s.	d.	
Wheat, 4 qr., at say	1*s.* 4*d.* ...	5	4	per acre
Barley, 5 ,, ,,	1*s.* 2*d.* ...	5	10	,,
Oats, 7 qr., ,,	11*d.* ...	6	5	,,

Delivering corn to station at a distance of two miles would mean one wagon with two horses and two men, and they would deliver 32 qr. of wheat or barley, or 45 qr. of oats, in one day.

2 horses at 1*s.* 8*d.* and 2 men at 2*s.* 6*d.* = 8*s.* 4*d.*

This works out, in the case of wheat or barley, to 3*d.* per quarter, and for oats 2¼*d.* per quarter—equivalent to 1*s.* per acre for 4 qr. of wheat or barley, and 1*s.* 4*d.* for 7 qr. of oats. As delivery entails marketing and market expenses, a charge is often made of 5*s.* per acre; but, in these days, marketing entails less expense than formerly, and the only charge which need be added is the cost of sacks at ½*d.* per week, for one week, which would be about 4*d.* to 6*d.* per acre. We shall therefore assume 2*s.* 6*d.* per acre as the total cost of marketing and delivering to the station.

We are now able to make a schedule of labour costs as follows for wheat:—

	£	s.	d.
Dunging at 16 loads per acre ...	0	8	6
Ploughing at the rate of 1 ac., per day, 2 horses	0	5	6
Extra, usually allowed for using skim coulter	0	1	0
3-horse rolling, 7 ft. 6 in. wide ...	0	0	8·6
8 strokes of the harrow before drilling, at 4⅛*d.*	0	2	9
Drilling with 2-horse drill 7 ft. 6 in. wide	0	0	6·6
1 stroke of harrow after drill ...	0	0	4·1
Total tillages	0	19	4·3
Spring rolling with 3 horses	0	0	8·6
,, harrowing	0	0	4·1
Harvesting	0	9	0
Threshing	0	4	10
Dressing (winnowing) twice at 2*d.* ...	0	1	4
Marketing	0	2	6
Total labour	1	18	1

To these the following must be added:—

	£	s.	d.
Brought forward, labour charges	1	18	1
Seed, 3 bus. at 5*s.* (good quality) ...	0	15	0
Dressing or pickling	0	0	6
Rent, rates, and taxes	1	5	0
Incidental expenses	0	2	5
Total cost per acre ...	4	1	0

We have assumed 4 qr. of wheat to be an average crop, and 32*s.* a fair price. The value of the crop is therefore £6, 8*s.*, to which 30*s.* may be added for the straw, making a total of £7, 18*s.* per acre, and a book profit of £3, 17*s.* per acre.

Cost of Growing a Crop of Roots after Wheat.—Wheat stubbles are often foul and require cleaning. In the following estimate the tillages

Tillages and Labour on 'Roots' (other than Mangel)

		£	s.	d.
1st series of cleaning operations	Paring stubble with an 18 in. share	0	2	9
	4 'draggings' or 4-horse harrowings at 8¼*d.*	0	3	1
	2 harrowings at 4⅛*d.*	0	0	8¼
	2 chain harrowings at 4⅛*d.*	0	0	8¼
	Collecting and burning weeds and spreading ashes, say	0	3	6
	1 ploughing	0	5	6
		0	16	2½
2nd series of cleaning operations	Repetition of dragging, harrowing, and chain-hsrrowing as beforc	0	4	5½
	Collecting and burning second coat of couch and weeds, say ...	0	2	6
	Applying 16 loads of dung	0	8	6
	1 deep ploughing with 3 horses	0	7	2
	1 cross ploughing in early spring	0	5	6
	2 4-horse dragging	0	1	4½
	1 rolling, 2 horses	0	0	6½
	2 harrowings	0	0	8¼
	1 light rolling before drill	0	0	6½
	Drilling with 2 horses	0	0	6½
	Harrowing before hoeing	0	0	4¼
	Horse hoeing, 1 horse, taking 45 in. and doing 5 ac.	0	0	9
	Singling and second hoeing let together at	0	11	0
	Second horse hoeing	0	0	9
		3	0	10½
	Dung not charged. (See *Note*, p. 235.)			
	3 cwt. of superphosphate at 3*s.*	0	9	0
	Seed, 3 lb. at 5*d.*	0	1	3
	Rent, rates, and taxes, about	1	5	0
		4	16	1½

are all supposed to be done by horses, because we have worked out the costs. It might be cheaper and better done by steam, but this is doubtful, and unless performed on the hire system, the costs of steam cultivation are extremely difficult to assess. There is always the serious item of 'supersession' by newer improvements, and the tremendous drop in value as soon as a set of tackle becomes antiquated. It is by no means certain that steam cultivation is cheaper than horse labour, and the very treading of horses, which is used as an objection to their use on stiff land, is actually beneficial on light soil. The same is true as to unlimited depth, which is desirable in some cases, but objectionable in as many others.

The root crop as it stands on the ground has cost £4, 16*s.* 1½*d.*, but a few shillings extra might reasonably be charged for heaping swedes and covering with straw. The ordinary estimate of £5 per acre as representing the cost of growing a crop of swedes or turnips is therefore borne out. As to the value of these crops, they bring the land into a clean and enriched position, which can only be realized in the increased yield of the remaining crops of the rotation, including the wheat which preceded it. Root crops have also an additional feeding value of an extremely variable nature, complicated by the fact that they are always consumed with other foods. The profits realized from the growing of root crops are therefore very variable. A moderate estimate might be £1 per acre.

Note.—The author does not charge dung, because it is produced on and returned to the land, and he considers it as belonging to the farm; while compensation is allowed for all cake and corn used in making it.

Cost of Growing a Crop of Barley after Roots

	£	s.	d.
1 ploughing	0	5	6
4 harrowings at	0	1	4½
1 drilling	0	0	6½
1 harrowing	0	0	4½
Rolling...	0	0	6½
Harvesting	0	9	0
Threshing	0	5	10
Screening and winnowing at 4*d.* per quarter (5)	0	1	8
Delivering	0	1	4
Marketing	0	2	6
	1	8	8
Seed, 3 bus. at 4*s.*	0	12	0
Rent, rates, and taxes	1	5	0
	3	5	8
If the produce is 5 qr. at 30*s.* the total value will be...	7	10	0
Book profit	4	4	4

Cost of Growing Clover after Barley.—The labour on this crop is not heavy, but consists in—

	£	s.	d.
Harrowing and rolling in the seeds	0	0	9
Wheeling in the seeds by piecework	0	0	4
Seed (clover and ryegrass)	0	12	0
Expenses on securing the hay crop	0	9	0
Rent, rates, and taxes	1	5	0
	2	7	1

	£	s.	d.
If 1½ ton of hay is got and valued at consuming value, or two-thirds of market price, taken at £3 per ton, it is equal to	3	0	0
Add for aftermath or second crop ...	1	0	0
Total value	4	0	0
Profit	1	12	11

Summary of Expenses and Profit

	Expenses. £	s.	d.	Value of Crop. £	s.	d.	Profit. £	s.	d.
Wheat	4	1	0	7	18	0	3	17	0
Roots	5	0	0	6	0	0	1	0	0
Barley	3	5	8	7	10	0	4	4	4
Clover	2	7	1	4	0	0	1	12	11
	14	13	9	25	8	0	10	14	3 in 4 years.

	£	s.	d.
The average annual expenses over the 4-years rotation are	3	13	5
The average annual yield is	6	7	0
The average annual profit is	2	13	6

The labour items are, including horse and manual labour—

	£	s.	d.
1st year, roots	3	0	10
2nd ,, barley	1	8	8
3rd ,, clover	0	10	1
4th ,, wheat	1	18	1
	6	17	8
Average yearly labour	1	14	5

These items do not include labour on live stock, which is more difficult to estimate; but if we take the total labour, both horse and manual, and deduct the above, we shall arrive at it by difference, more or less accurately.

	£	s.	d.
Total manual labour	1	7	6
,, horse ,, ...	1	0	0
	2	7	6
Less labour on crops	1	14	5
Balance against labour on live stock, &c.	0	13	1

Wages

The agricultural labourer is not highly paid, but his expenses are much less than those of town labourers. He often occupies a rent-free cottage and garden, and his average earnings are not represented by the winter's wage of 12*s.* to 15*s.* a week. On most farms every labourer has a 'chance'. One receives 1*s.* a day extra when feeding the threshing machine, chaff cutter, mill, or cake breaker. Another does thatching

by piecework; others are hoers, mowers, sheep-shearers, &c., and earn high wages. All are paid extra when threshing, and receive high wages during haytime and harvest. A good labourer probably earns on an average from 16*s.* to 18*s.* a week, and sits either at a low rent, or rent-free. The regular staff on a farm enjoy privileges as well as higher weekly wages, and in many cases teamsmen receive £5 at Michaelmas instead of the higher wage given to regular and casual labourers in harvest. The lot of the agricultural labourer is not a hard one, and fairly good men are seldom out of employment. See also Piecework.

Organization of Labour on Farms

In this connection it is necessary to emphasize the importance of the permanent 'staff', as cementing the various interests on the farm into one harmonious whole. As each head of a department is assisted by helpers, working directly under him, it is his privilege to take notice of incapacity, absence from duty, impertinence and insubordination. This greatly simplifies the management of labour, for, after deducting the hands directly under responsible men, there are not many left. It is one of the advantages of extensive farming that the dairyman, the shepherd, and the head carter are each fully occupied in their own spheres, and they form a grade of highly skilled men, above ordinary labourers. They are not told off to miscellaneous descriptions of work; while labourers are expected to do anything they are told. Ordinary labourers may be sent to help in the cattle sheds or the sheep pens, the work-horse stables or on the land; and cannot object to any class of work to which they may be ordered. This is not the case with head men, for a shepherd would not understand being asked to help in the barn, and a dairyman would object to hoe turnips. Such men form the backbone of the labour organization, and a self-acting body deriving inspiration from the master or his bailiff, without being subjected to constant or petty interference.

We shall next proceed to consider the arrangements of labourers in the carrying out of all operations capable of systematic combination. This is best done by first glancing at the duties of the heads of the various departments, and then at the arrangements for carrying out the most important descriptions of work.

The *foreman*, farm bailiff, or farm steward, is an important person on large farms, or on holdings in which the master does not wish to be too exclusively employed in farming. In some cases the head man practically manages the farm, and sells and accounts for the produce. We, however, regard him in the present connection as in daily contact with his master, and as acting for him in his absence. He in many cases takes an active part in manual work, and may drive the engine, weigh up corn, look after stores, give out horse corn, repair fences, dispatch produce, &c. His principal occupation is, however, that of superintendence.

Stable Management.—In Scotland, and the northern counties of England, it is the custom to give a pair of horses to each ploughman, often termed a 'hind' or cottager. These men are responsible for their own horses, and go out with them daily. In most of the southern counties the stable is looked after by a head ploughman, head carter, or horse keeper, who is responsible for all the horses under his care, feeding them and attending to all their wants. A head carter may have charge of six or eight horses, and is then assisted by a second or under carter, a third hand, and if there are eight horses, a boy who can 'hold plough'. This makes a party, and if there are two stables, as often happens on large farms, there is a second head carter with helpers, exactly as in the first case. This arrangement works well, as the head carter is a man of age and experience, who understands horses, and all sorts of work, such as the use of self-binders, drills, and wagon work of all kinds. He also sees that the horses are properly shod, and reports upon any matters of importance occurring in or out of his stable. He is an expert on the land, and may be consulted with advantage as to the tillages necessary for cleaning or preparing it for sowing. A good head carter, in some cases, takes the place of a foreman, and his opinion, on matters which fall within his province, is worthy of attention.

Dairy Management.—The dairyman is another responsible person. He understands the calving of cows, the farrowing of sows, the management of poultry, and is an expert cheese and butter maker. He stays up at night when necessary, and is out early in the mornings. On a well-organized farm, the master leaves many matters to his dairyman, although he takes his share of watching and waiting in critical cases of parturition, or of illness. The dairyman is given help according to the number of animals under his charge. He is competent to look after 100 cows, but in large dairies he must be supported by milkers at the rate of one to 10 or 11 cows. The milkers also assist in feeding and cleaning out or littering up the cows, but those who are not required for such purposes are found work of any ordinary kind upon the farm.

The *shepherd* is responsible for the flock, and if he is worthy of his post does not need to be reminded of his duties. As a class, shepherds are competent men, and enthusiastic in their devotion to their charge. The shepherd is allowed an under shepherd, and a boy or two, according to the size of his flock, and such assistance as is required for shifting hurdles, littering up lambing pens, carting hay and roots, &c.

The *labourers* are employed in all kinds of work, as has already been explained. They ought not to be numerous, and on a farm of 700 or 800 ac., under ordinary management, six may be enough. They may include a meadow man, who can thatch, a man who understands barn work, and another who is skilful with fences. They are all willing to take on task work, or to assist with live stock.

Strappers.—During the busy season, from May to October, extra men may be necessary for hoeing root crops, mowing, and securing pro-

ducts. These men are paid at a higher rate per day than the ordinary hands, but have no claim to expect work in winter.

Thus it will be seen that on a well-organized farm the machinery, so far as labour is concerned, goes on smoothly under the master and his foreman. With the latter he frequently converses, and hears all about the work, the conduct of the helpers and boys, and the progress of the animals. Good head men are most important to the success of the farm, but the master cannot be said to be dependent upon them. On the contrary, if he has reason to be dissatisfied with any servant he discharges him, and looks out for another. While this is no doubt true, it is equally incumbent upon him to duly value and retain good servants.

General Course of Tillages

Cleaning Land.—In the autumn cleaning of land, all the operations tend towards the destruction of weeds. The first cultivations are shallow, in order to detach the weedy surface, and especially the stolons of couch, from the deeper soil. Deep ploughing is to be shunned until the coat of weeds is thoroughly removed, and after this is accomplished, dunging and deep ploughing follow. Various methods are used, which may include steam cultivation or not, according to circumstances. We therefore give two typical systems, which can be modified according to the character of the soil and its degree of foulness. They are as follows: (1) Light steam cultivation about 4 in. deep, which is best repeated by crossing the work, and this ensures the complete moving of the soil to the necessary depth; (2) horse dragging; (3) rolling; (4) harrowing; (5) chain harrowing; (6) raking weeds and couch together; (7) burning them on the land and spreading the ashes. If the operation is done without the assistance of steam power, it will be carried out as follows: (1) Thin ploughing, or paring, after which the operations 2 to 6 are performed in the same order. As soon as the first crop of weeds is disposed of, the land may be ploughed about 4 in. deep, and the same course of subsidiary cultivations gone through, ending in burning and spreading the ashes. In the case of foul corners, or patches, the same course may be necessary a third time, and, after such a 'doing', the foulest land should be clean.

The cleaning of land is one of the most expensive items of labour, and a great saving is effected when it is unnecessary. In such cases all the above operations may be omitted, and dunging and deep autumn ploughing at once proceeded with, upon the unbroken stubble.

Cultivation of Corn Crops.—The routine varies in detail (see various articles on cultivation of cereals), but generally consists in (1) dunging or close folding; (2) ploughing; (3) harrowing; (4) drilling; and (5) harrowing. In some cases the land presser follows the plough, and in others the roller; and there are certain differences between broadcasting and drilling. For instance, in broadcasting the principal harrowings follow sowing; but in drilling they precede it—with the exception of one single stroke after the drill. The following are brief statements of the operations required in the principal tillage operations:—

Drilling Turnips or Swedes on the Flat.—(1) Cleaning as above; (2) ploughing; (3) dressing (dragging and harrowing); (4) rolling; (5) drilling; (6) harrowing; (7) light rolling.

Drilling Roots with Water Drill.—The same as above, but four horses will be required on the drill, and two or three water carts, with two horses in each, according to the distance from the source of water. This work often demands twelve horses and five or six men, and is therefore much more expensive than dry drilling.

Sowing or 'Making' Turnips on Raised Ridges.—(1) Thorough cultivation and cleaning of the field; (2) two teams raising and splitting 27-in. ridges, *i.e.* raising one way, and splitting the other. Two or three men filling dung at heap; one man drawing out dung in every third raised ridge; six women spreading dung carefully in the bottoms of the ridges. In this case the raising and splitting take place on either side of the spreaders, who work in a space of about twelve raised ridges, lying between the last raised and the last split ridglet, and the work proceeds steadily across the field, about 4 ac. constituting a day's work. The seed is sown, later, from a 2-rowed turnip drill drawn by one light horse driven by the foreman, or sometimes by the farmer himself. The artificial manures are scattered by hand along the ridges, on the dung, before splitting the ridglets.

Potato planting may be done in a similar manner, the 'sets' being deposited at regular intervals on the dung and artificials, before splitting the ridges. In this case the field is divided into three or more lengths, each occupied by one planter.

Dung Carting.—Three fillers; in some cases two, and a strong boy; in others four fillers, in order to push on the work rapidly. Carts according to distance, but never less than two. One extra cart for every quarter-mile beyond the first quarter. One man, usually the head carter, drawing out the manure into small heaps, and boys to lead, according to the number of carts.

Hay Carting.—Two pitchers, two loaders, one horse-raker; two men in front of pitchers, 'cocking' or 'pooking'. One man unloading at rick on to elevator; one horse in elevator; four or five men on rick. When the hay is already in cocks or coils, the two pookers can be dispensed with. Three wagons, or 'long carts', if stacked in the field, or according to distance.

Wheat or Oat Carting.—Two pitchers, two loaders, wagons according to distance, with drivers. One or two pitchers unloading; one rick builder, and three helpers on the rick. This constitutes one double set.

Barley Carting (*loose*).—The same as hay carting.

In carting hay or corn, the amount cleared in the day depends upon the pitchers or forkers. In ordinary circumstances they may each pitch 7 ac. of crop; but if it is required to finish the work quickly, two double sets should be put on, and 28 to 30 ac. will then be cleared in a day.

Threshing in the Field.—This work requires about nine men: one engineman; one feeder; one man to cut bonds, two or three pitchers on the rick; one man on straw rick, with elevator geared to engine; one man at the sacks; one man attending to chaff and cavings; one boy and horse water-carting. One carter with horses and wagons (or two in some cases) carting corn home. In threshing barley, only eight men will be needed. This estimate is based upon a 54-in. drum, and an 8-h.p. portable engine.

Chaff cutting may be done simultaneously with threshing, but is more ordinarily carried out separately. It will then require one man at the engine; two men feeding straw to chaff cutter; two men carrying away quarter bags with chaff; three or four men, with two wagons, bringing hay or straw to feeders from rick. Powerful cutters will convert one ton of straw into chaff in twenty minutes.

Winnowing where men are employed. One man turning the handle of winnower; one man feeding corn into hopper; one man filling sacks; one man holding sacks, and weighing them off on weighing machine, close at hand.

Screening Barley.—One man turning handle; one man feeding into hopper; one man throwing back screened barley, and attending to screenings.

Gathering Potatoes.—One team ploughing out tubers with potato lifter. Nine men gathering the tubers and placing them in carts. In this work the total length of the furrow is divided into three sections, with three men in each length. It is well to plough up alternate drills first, and take the remaining rows after the first are gathered. The land is then harrowed, in order to expose hidden tubers, and later, when the land is ploughed, a gatherer follows each plough to pick up the remainder.

Mangel pulling is best let at 8*s.* 6*d.* per acre, to include filling into carts. Four men pulling and loading on to carts, three or more carts according to distance; boys according to carts; one man building heap, and covering it with loose straw. The covering with earth and thatching is done later.

Heaping swedes for sheep is generally let at 7*s.* or 8*s.* per acre (see PIECEWORK).

ORGANIZATION OF LABOUR FOR LIVE STOCK

Sheep.—One shepherd will take charge of a flock of either 500 or 1000 ewes. In the latter case there will be a good second shepherd, but in most cases a shepherd with one or two helpers, according to the number of sheep, will do the work. Extra help is needed at lambing time and in busy seasons.

Sheep Washing.—The shepherd sees that each sheep is well washed and comes out of the water safely. Two men throwing sheep into the wash pool; two helpers; drivers to bring sheep to and from the pool.

Sheep shearing is best done by a company, who take the work at 3*s.* 6*d.* or 4*s.* 6*d.* per score. The shepherd superintends, and two extra hands catch, draw out, and present sheep to shearers as required. One, or in some cases two men, tying up fleeces and storing them.

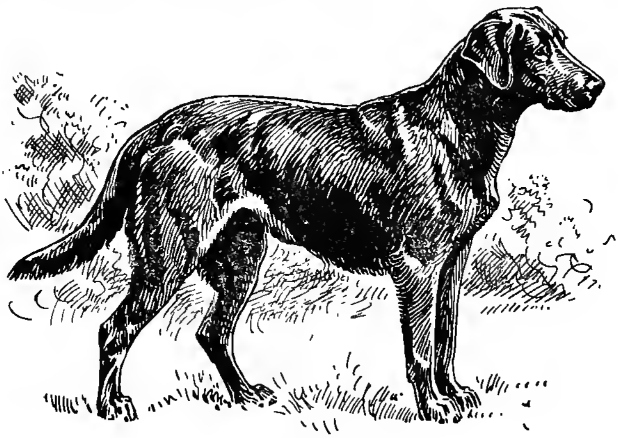
Dairy Cows.—One dairyman will look after any herd up to 100 cows. One milker (the dairyman being one) for every 10 or 11 cows. The milkers are employed on the farm between milking times, excepting those required for feeding and mucking out or for attending to pigs, &c.

Fattening Cattle.—One man will look after forty fattening bullocks, but a great deal depends upon the arrangement of the buildings, and the facilities for conveying and mixing food.

Stables. See previous remarks.

Effect of Power on Labour.—Before a correct idea can be obtained of the entire subject of labour on farms, the influence of steam, water, wind, electric and motor power must be studied, as well as labour-saving implements. The reader is therefore referred to the numerous articles on these subjects. [J. WR.]

Labrador Dog.—There is a very close association between this admirable variety of sporting dog and the flat-coated Retriever, in fact the latter is a direct descendant of the former. As a field dog the Labrador, whose merits have somehow not been as widely recognized in the past as they deserve to be, has been steadily advancing in favour of late, and the better he is known the more highly the Labrador is esteemed by shooting men, as he has a wonderful nose, is easily broken and kept under control, and his merits as a water dog are exceptionally high.



Labrador Dog

So far as his appearance goes the Labrador may be roughly described as a compromise between a powerfully built Retriever and an undersized Newfoundland, and it may be added to his credit that he possesses many of the beauties of both breeds. His head is rather large and

wide between the ears, but there is no coarseness about it. It is flat on the top, and a slight groove runs down the centre towards the eyes, where there is a slight rise. The muzzle is powerful, the nose large, the eyes rather inclined to be oval in shape and of a brown colour, the ears being broad at the top and carried flat to the sides of the head. The neck though powerful is long and graceful, the shoulders sloping, and the chest deep but not very wide. The body is long, the loins extremely powerful, as is the back, whilst the fore legs, which must be straight, should be well furnished with bone and muscle. The black coat is profuse and weather-resisting, lying close to the body and free from curl. The weight of a typical Labrador dog is about 75 lb. [V. S.]

Labradorite, a lime-soda felspar, and a common constituent in basalt and gabbro. See art. FELSPAR.

Laburnum is a genus of the Papilionaceæ sub-family of the nat. ord. Leguminosæ. Like the other genera of the Papilionaceæ, including the Robinia or false Acacia, broom, gorse, beans, clover, peas, and vetches, its leaves are compound, stipulate, and untoothed, and it is characterized by the shape and construction of its irregular five-petalled flower (having a keel, two wings, and a standard), in which the five sepals are joined, the five petals more or less completely separated, and the ten stamens united to become a tube surrounding the single carpel forming a one-chambered ovary containing several ovules, a single style, and a single stigma; while the fruit is a pod usually opening lengthways along two lines. The genus Laburnum (syn. Cytisus) consists of ornamental trees and shrubs with spirally arranged, stipulate, compound leaves each having three short-stalked leaflets, and with long pendulous racemes of pale-yellow blossoms. Five species of Laburnum are indigenous throughout central Europe, but only two of these are common in Britain, the Common Laburnum, *L. vulgare* (syn. *C. Laburnum*), a large shrub or small tree of from 15 to 30 ft. high, introduced into Britain about 1596; and the Scots Laburnum, *L. alpinum* (syn. *C. alpinus*), a dwarfish variety found in colder climates, but closely resembling the other in appearance and habit. The Common Laburnum has a cylindrical stem with smooth, dark, shiny bark, which peels off transversely in curly, parchment-like rings. In June and July its small, bright-green, shining foliage and its long clusters of pale-golden flowers (mainly pollinated by bees) make it a beautiful object in parks and gardens, where it is freely exposed to sunshine. It is only cultivated for its ornamental qualities, although its hard, heavy wood (much resembling *lignum vitæ* and ebony), with yellow sapwood and blackish-brown heartwood, takes a fine polish and is used for inlaying and cabinetmaking. In the mountains of central Europe, however, it grows spontaneously in the woodlands, like holly. It can grow fairly well in most kinds of soil, but attains its largest size on a deep, dry loam; and of course it grows best and flowers most profusely in a sheltered situation. The seed pods should be gathered in October and stored in a dry airy place till the dark brown-black seed (which is *poisonous*) is needed for sowing thinly on beds of light soil and covering with about $\frac{1}{4}$ to $\frac{1}{2}$ in. of mould about the end of March. Yearling seedlings can be transplanted into the nursery lines till large enough to plant out. There are many garden varieties of the Common Laburnum. Of these the most interesting is the *L. Adami*, which often simultaneously bears yellow and dirty-pink or purple flowers, and which is considered a hybrid between the common and the purple Laburnum (*L. purpureum*). [J. N.]

Laburnum Blister Moth, a small moth with a wing expanse of $\frac{1}{4}$ in. which in its larval stages causes round blisters on the leaves of the Laburnum tree. See art. CEMIOSTOMA LABURNELLA.

Lac, a resinous substance and also a dye derived from an Indian insect (*Tachardia lacca*, Kerr) of the family Coccidæ. There can be no doubt that the insect is indigenous to (in fact even to-day almost confined to) India, and exists in a wild, or occasionally only (in Assam and in Sind) in a semi-domesticated, condition. It has been known in India, in fact, from the most ancient times, but, curiously enough, no definite references to it occur in the classic literatures of Greece, Rome, Egypt, Persia, Africa, or China. All the passages that have been taken to indicate the resin or the dye (other than Indian) refer to a red dyewood, or to the insect *kermes*, or to a resin at present unidentified, but certainly not Indian lac. In the Periplus (80 A.D.) we have, however, a distinct mention of lac as exported from India. Then Pegolotti, in the 14th century, speaks of the 'lacca' found on Indian trees; Nicolo Conti, in the 15th century, discusses the lac of Cambay; and Varthema, early in the 16th century, describes the lac of Pegu; so that from the dates indicated it may be accepted the European knowledge in both products was fully established. Thus the period of the struggle for European supremacy in the East was practically that of the birth of all definite knowledge in lac. The demand for cochineal (largely used in dyeing the woollen uniforms of the soldiers) served the useful purpose of pointedly directing attention to lac dye. The scenes, materials, and persons changed rapidly: from the Portuguese on the west coast of India to the Spanish in Burma and Sumatra, and finally to the British back again to Bombay, and ultimately across India to the United Provinces, Bengal, Assam, and lastly, once more to Burma. So also interest shifted from the dye to the dye and resin, and to the resin only—the present-day material of trade. But Sir W. H. Perkins's discovery of aniline struck at once the deathblow to Mexican cochineal and to Indian lac dye. In consequence the interest changed, until the dye became first the by-product and ultimately the waste material of the factory. Amid all these fluctuations there came into force methods of utilization of lac resin and systems for its collection, purification, and manufacture that are mostly quite foreign to India, so that, although produced exclusively in that country, the present traffic

may not only be described as modern, but vastly in excess of India's necessities. It has been created by modern foreign demands, and is controlled by European capital. In the story of lac, therefore, we have once more a demonstration of the indebtedness of India to Britain for her modern commerce. - But the English language has derived the word 'lake' (as applied to a pigment) from the Sanskrit *lāksha* and the Hindi *lākh* (lac), as it did 'crimson' from the Greek *kermes*, 'vermilion' from the Latin *vermiculus*, and 'cochineal' from *cochinella*—all words that denote dyes closely allied to lac dye.

Upon the twigs of certain jungle trees (and of one or two specially cultivated ones), met with on the drier low mountainous tracts of India, minute hemipterous insects abound. These subsist upon the juices of the trees, and for that purpose become fixed, when each has successfully inserted its proboscis to the food supply. The adult females have no power of future locomotion, but the males on attaining maturity emerge from their pupal cases, become possessed of a pair of long transparent wings, and fly away to visit the females. At two, or in some cases three seasons, swarming of larvæ takes place, viz. July and December, or also January. The very minute larvæ (not more than one-quarter the size of an ordinary pinhead) run off in search of new feeding grounds, or are wafted by the breezes or borne on the feet of larger insects, birds, squirrels, &c., from twig to twig. In time they become fixed, their feet being useless drop off, and a resinous excretion begins to form around their bodies, intended doubtless as a protection, but which, by the aggregation of many, in time assumes the condition of a more or less complete encrustment of the twigs, fully ¼ in. in thickness. This is the lac resin; but the bodies of the contained insects (more especially of the larvæ before they escape from the mother cells), being of a brilliant red colour, afford the lac dye or 'lake'. The encrusted twigs are broken off the trees and sent to market—'stick-lac'. The collecting seasons for the one crop or brood is May to June, and for the other October to November, or just before the respective swarming periods. At the factory, stick-lac is beaten or trodden by foot under water until the masses of lac break off from the contained twigs (which float to the surface and are removed), while the further treading breaks the lac up into small somewhat rounded pieces, known as 'seed-lac', the while that these are washed clean and deprived very largely of their colour. The red fluid of the washings, filtered to remove impurities, is boiled down to a thick earthy-like substance, baked into cakes, and dried—'lac dye'. The washed seed-lac is next fused before a long shallow open fire, and while thus liquid it is squeezed through the texture of the long bags in which it is contained. The molten lac thus procured is subsequently spread out into very thin sheets, on tubes of zinc kept hot with water within. This constitutes 'shell-lac'. Instead of being spread out into thin sheets, the lac may be dropped on a smooth surface—'button lac'. In some cases the seed-lac is bleached before being fused, in order to still further remove its objectionable red colour. In other cases it is mixed with a small quantity of arsenic (orpiment), in order to make it opaque and straw-coloured. Arsenic is not employed in the preparation of 'garnet' (thick red-coloured sheets) or 'button' lacs, nor in grades of shell-lac where fullness of colour is no objection. So again pine rosin (mostly Canadian) is mixed with seed-lac, owing to the well-ascertained fact that the fusing temperature is thereby lowered. This has been known at least since Acosta's time, 1578. The purpose of the admixture is thus not only fully admitted, but is essential for certain industries; and in the trade, 2 to 5 per cent rosin in shell-lac is freely accepted, but at times higher proportions are used, and then for the most part assume the condition of deliberate adulteration.

It may be here mentioned that there is an aspect of the lac trade that is sometimes overlooked, though it is of the greatest importance to India. Lac production is primarily a sylvan occupation. To the inhabitants of the wild tracts, where the insect abounds, the collection of stick-lac assumes the position of great importance; it not only makes such tracts, otherwise almost valueless, of considerable importance, but at the same time relieves the pressure of population on the cultivated districts. The first recorded exports from India (in what may be called modern times) took place in 1607, but two hundred years later the traffic in shell-lac came to only 239 cwt., valued at £1243. In 1868–9 the exports of lac dye were valued at Rs7,96,655 (or say £53,300), and of shell-lac at Rs11,65,739 (£80,000). Since then the trade in lac dye has gradually disappeared, while the exports in resin have expanded to close on £2,000,000. Bengal, the United Provinces, and the Central Provinces are the chief producing areas, smaller quantities coming from Assam, Burma, and Sind. The Indian factories (some of which are worked by steam, others exclusively by hand labour) are practically confined to Mirzapore in the United Provinces, and Calcutta in Bengal. Formerly the bulk of the exports went to the United Kingdom. The traffic, for example, in 1885–6 was as follows: to the United Kingdom, 72,463 cwt.; to the United States, 24,797 cwt.; and to the Continent of Europe, 13,483 cwt. By 1906–7 a complete change had been effected, and the three chief countries of demand were the United States, 109,047 cwt.; the Continent, 48,920 cwt.; and the United Kingdom, 43,837 cwt. It will thus be seen that while the exports from India have steadily expanded, the United Kingdom has not maintained its supremacy. [G. W.]

Lacewing Flies.—These flies form a section of the order Neuroptera, and are represented by over forty species in this country. The better known of these are the large greenish flies (Chrysopidæ) with gauzy wings having several long veins and numerous short cross veins. The flies when alive have very brilliant golden eyes, and certain species are said to give off a dark liquid having a very disagreeable

odour, and from this fact they are called by the Germans 'golden-eyed stink flies'.

Another numerous group are the Hemerobiidæ, in which the insects are much smaller in size and partake of a warm grey colour; the venation is somewhat similar to that in the above group, but certain species have the veins dotted with darker or lighter streaks or spots. The larvæ of all these flies are aphidivorous, and thus are of great service to the grower of plants or trees which are subject to attacks of 'green fly', as they are the natural enemies of the plantlice (aphides). The eggs of many of the Lacewing flies are placed on long stalks, so that the plantlice may walk upon the surface of the leaf without injuring the egg of the Lacewing. When the young larva is hatched it is of a bright-yellow or orange marking, with a pair of very large sickle-shaped jaws which will easily crumple up the wings and bodies of any plantlice which come within their reach. [J. J. F. X. K.]

Lachnus viminalis (the Giant Willow Aphis) is one of the largest of the Aphidæ, measuring nearly $\frac{1}{4}$ in. in length. It attacks willows and osiers in the autumn, sometimes with disastrous or even fatal effect, though in other cases little harm seems to be done. The insect is not found on the leaves, but attacks the stem, forming large and conspicuous colonies of closely packed individuals, all ranged with their heads directed upwards. They give forth a copious exudation, which injures foliage upon which it falls, and which seems to have a special attraction for wasps. The insect is grey-brown, with rows of dark spots. On small trees the colonies are best destroyed with the gloved hand or with a cloth. The best wash for larger trees is a strong soft-soap emulsion (12 lb. to 100 gal.) with quassia added. [C. W.]

Lackey Moth. See Clisiocampa neustria.

Lacon murinus (Mouse-coloured Click-beetle) is the parent of a wireworm which is generally found under stones, and feeds on the roots of grasses. The beetle inhabits cornfields and sandy situations during the spring and summer. It is broad and flattish, clothed with short ashy hairs marbled with brown; the antennæ are short; the legs are of a pitch colour. The insect is about $\frac{1}{2}$ in. in length. [J. C.]
[C. W.]

Lactarine, or **Casein Gum,** is a by-product of the dairying industry, and consists of nearly pure casein. When dissolved in ammonia it is used for fixing and thickening colours in calico printing. Lactarine has also been found to be specially valuable for the preparation of sizing for paper. Being practically pure casein, it may be put to any purpose which that substance serves (see Casein). The manufacture of lactarine was formerly a profitable business in many dairies where buttermaking was pursued, but it is now made in limited quantities only. The method adopted is as follows: The best results are obtained by using buttermilk obtained from whole milk lappered and churned in the usual way. The following day the buttermilk is filled into a small cauldron or other form of heater, and placed in a boiler in which water is kept boiling. The heat causes the curd to rise to the top, and in order to get it cooked evenly it must be turned down occasionally, otherwise it will remain soft on the top. Where steam is available it may be passed through the cauldron in order to effect the coagulation. When sufficiently curdled, it is ladled into cheese cloths tied at the corners and hung up to drain. The object of the succeeding operations is to further dry and compress the curd by turning it on racks and pressing it, just as cheddar curd would be treated. When taken out of the cloths the following day it is broken a little and then packed into a cheese dripper and put into a press with a 28-lb. weight to further reduce its content of whey. This operation is repeated for from twenty-four to thirty-six hours, using an ordinary chesset with a weight of 56 lb. The following day the compressed curd is put through the curd mill twice, rubbed through a riddle or sieve to render it finer, and spread out on trays. The latter are simply wooden frames about 36 in. square, with calico tacked on to form a tray. The drying house is fitted with three or four tiers of racks 15 in. to 18 in. apart, and running right round the house. Usually there is a fire on either side of the door, the flues going up each side under the racks. The curd is stirred five or six times a day. In two or three days it should be sufficiently dried and hardened for grinding at the meal mill, from which it is received back in its marketable form.

About thirty years ago lactarine realized from 7*d.* to 10*d.* per lb., and makers calculated on having 1 lb. of lactarine for every 1 lb. of butter. At the present time 4*d.* per lb. is about the maximum figure attained — a price which is barely sufficient to compensate for the labour involved in its manufacture. Dried casein for the purpose above mentioned can also be prepared from separated milk, by precipitating the curd with $\frac{1}{2}$ to 1 per cent of a mixture of acetic and sulphuric acids. The whey is drawn off and the curd washed two or three times in warm water, and afterwards compressed and dried in the manner above described. [J. B.]

Lactic Acid. — Lactic acid, $C_3H_6O_3$, or $CH_3CH(OH){\cdot}COOH$, is the chief product of the natural souring of milk, in which the lactose or milk sugar is changed into lactic acid. Other substances may undergo this kind of fermentation, such as other sugars, starch, &c., and considerably over a hundred different ferments may bring the change about, when present at a suitable temperature in a medium containing these substances, and nitrogenous and other suitable plant foods. The change is never quite a simple one, but may be represented to some extent by the following equations:—

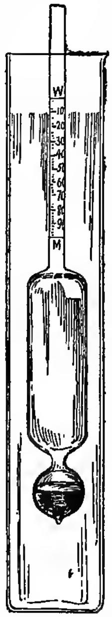
$$\underset{a\text{-Lactose.}}{C_{12}H_{22}O_{11}},\ H_2O = \underset{d\text{-Glucose.}}{C_6H_{12}O_6} + \underset{d\text{-Galactose.}}{C_6H_{12}O_6} \text{ and}$$

$$\underset{d\text{-Galactose.}}{C_6H_{12}O_6} = \underset{(d\,+\,l)\text{ Lactic acid.}}{2CH_3{\cdot}CH(OH){\cdot}COOH.}$$

Acetic acid and carbonic acid gas are also formed by many kinds of lactic ferments, and the above equation only gives an indication of the general nature of the change. The temperature most suitable for the production of

lactic acid varies with different kinds of organism, but in milk at least about 97° F. is the most favourable temperature. From the point of view of the butter and cheese maker, organisms which grow with little or no air are the most favourable, some of the aërobic types, or those which grow with air, producing a less desirable fermentation. The lactic acid produced soon inhibits the further development of the organisms unless this substance is removed or neutralized. In the preparation of lactic acid for technical purposes from beer, wort, or whey, the lactic acid is neutralized with calcium carbonate. Lactic fermentation plays an important part in the production of ensilage and brown hay. It has also been used for acidifying distillery mash to prevent the development of butyric acid. Dilute lactic acid is not injurious to health, and properly soured milk is used for medicinal purposes. Lactic acid, when pure, is a thick, sour, hygroscopic liquid; it is soluble and miscible in all proportions with water, alcohol, ether, and glycerol. It is insoluble in petroleum ether. [J. GO.]

Lactometer, a modified hydrometer of limited range suitable for determinations of the specific gravity of milk. A lactometer usually consists of a closed glass bulb or cylinder, attached at one end to a smaller bulb, which is weighted with mercury or shot, and at the other end to a graduated glass stem on which the specific gravity of the liquid can be read when the instrument is placed in it. In some instances there is also another bulb filled with mercury, forming the bulb of a thermometer, the temperature registered by which can be read on the upper part of the stem of the instrument; if this is not provided, the temperature should always be read on a separate thermometer, and either adjusted to 60° F. or corrected to this temperature by reference to a table.



Lactometer

A lactometer does not register the weight of a unit volume of liquid (the true specific gravity), but the volume of a unit weight; the graduations should, however, be so arranged as to give readings which correspond with the true specific gravity.

The stem of a lactometer, which should be very thin in proportion to the bulb to allow of the graduations being fairly wide apart, should have the graduations marked on a firmly fixed scale; for milks it is sufficient if these begin at the top with 25 and finish at the bottom with 40. This means that the top graduation represents a relative density of 1·025 and the bottom 1·040, compared with water at 60° F. as 1. The marked divisions will then be 25, 30, 35, and 40, and the scale is divided into five divisions between the marks, and can easily be read to half a division.

To determine the specific gravity of milk with a lactometer the milk is placed in a sufficiently large vessel to allow of the instrument floating freely; the temperature is then taken, and, if necessary, the milk is cooled or warmed to 60° F. (unless a table of correction is to be used). The lactometer is then lowered into the liquid, and the height at which the liquid cuts the stem is noted when the instrument has come to rest. The liquid is attracted up the stem, but this with a little practice can be allowed for. [J. GO.]

Lactose. See SUGARS.

Ladders.—Ladders used on the farm differ considerably in length and substance. Oak or ash form the strongest sides, but owing to their weight they are little used except in short ladders; fir, owing to its straightness, sufficient strength in spite of its lightness, answers best for long ladders. For stack work the rungs or rounds forming the steps or treads are made round, the middles being stouter than the ends. Thatching ladders contain from forty to forty-eight rungs as a rule, according to the size of stack ordinarily built, though where small stacks are built, shorter ones will suffice. Eaves ladders, for use when building the stack, have usually from twenty-eight to thirty-five rungs. Emptying ladders, enabling a man to get on to the top of loaded wagons, have about sixteen rungs. Sack ladders, for use in carrying sacks on to a wagon, are made of specially strong wood, usually oak, the steps in this case being made broad and flat, and placed rather closer than in stack ladders, and are about 7 ft. to 8 ft. long. Granary ladders are made similarly, the length being regulated by the height to the doorway. For fruit gathering, light ladders are used; in some districts they are made specially wide at the foot so as to give a broader base, and thus be less liable to fall sideways if, through the yielding of branches, the top slips. Light telescoping ladders are convenient for fruit gathering, as are folding steps. Folding steps are well suited to hop tying, as there is no support for the top, and stability can only be obtained by stretching out the feet. Folding steps may have the telescoping principle applied to them. [W. J. M.]

Ladybird. See arts. COCCINELLA and ADALIA.

Ladyday, the 25th day of March, one of the regular quarter days in England and Ireland.

Lady Fern (*Asplenium Filix-femina*), a native fern which is of very cosmopolitan character, being extensively distributed over Europe, Asia, Africa, and North America. The fronds, 1 ft. to 3 ft. long, and 6 in. to 12 in. broad, which are borne on erect stalks 6 in. to 12 in. long, are exceedingly graceful; indeed, it is the most decorative of the British ferns. It is easily grown, but to appear at its best it must be well supplied with moisture; it is therefore well suited for the margin of shady walks, or for a position by the side of water. There are a large number of varieties of this fern; several hundred distinct and beautiful forms are known to collectors, and a work upon British ferns should be consulted for information as to the best of these. [W. W.]

Lady's Bedstraw, a perennial weed with small yellow flowers, which is commonly found on sandy and chalky soils. See art. BEDSTRAW.

Lady's Fingers, the popular name for the Kidney Vetch, for a description of which the reader should consult the article under that title.

Lady's Mantle (*Alchemilla vulgaris*) is a perennial weed belonging to the nat. ord. Rosaceæ, and to that part of the order which is destitute of petals. It frequently occurs in moist pastures and by the sides of streams. The plant has a short, stout, underground stem (rhizome), which is black, and bears the handsome ground leaves, almost as broad as long, from 2 in. to 6 in. according to the luxuriance of the plant. This leaf is very characteristic, for the pair of wing-like outgrowths from its base (stipules) are grown together so as to form a tube with a toothed margin; the blade itself has from seven to nine ribs springing from a point, and a corresponding number of plaited and rounded lobes fringed with saw-like teeth (serrate). In the sunshine these blades are often seen glistening with what appear as blobs of dew. Microscopic examination shows that each tooth on the margin of the leaf has a special pore for allowing any surcharge of water to escape, and this water escape accounts for the dewy appearance. Ordinary pores allow vapour to escape, but these special pores belong to 'water stomata', which allow the water to escape in liquid form. From the axils of the ground leaves numerous branch stems rise into the air to the height of 6 in. or 12 in. or more. These air stems end in forked clusters of inconspicuous green flowers. Each flower is about $\frac{1}{8}$ in. diameter, and requires a lens for examination. An interesting biological peculiarity of the Lady's Mantle is its power of producing seeds and embryo plants without any application of pollen to its stigma (apogamy). The plant is never troublesome to the agriculturist, and is sometimes eaten by stock. An annual species of Lady's Mantle called Field Lady's Mantle and Parsley Piert (*Alchemilla arvensis*) frequently occurs as a weed in cultivated gravelly fields. This is a very diminutive plant, often 1 or 2 in. high, and always below 6 in., bearing small leaves with three-lobed blades. [A. N. M'A.]

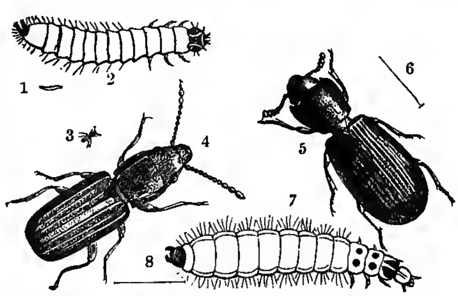
Lady's Mantle (*Alchemilla vulgaris*)

1, Vertical section of flower.

Lady's Smock (*Cardamine pratensis*), also called Cuckoo Flower and Bitter Cress, is an erect perennial cruciferous weed prevalent in meadows which are wet and undrained. The underground stem (rhizome) is short, stout, and densely clothed with roots. The ground leaves from this underground stem have blades composed of many roundish leaflets arranged along a midrib (compound imparipinnate leaves). The air stems are 1 or 2 ft. high, with leaves composed of narrow (not roundish) leaflets. In springtime, when the primroses are in bloom, we sometimes see the meadows covered as with linen bleaching; this appearance is due to the Lady's Smock, which at this early season is producing its showy white or sometimes lilac blossoms in clusters (corymbs) at the end of the air stems. When the plant is in fruit, the pods (siliqua) are seen; they are erect, narrow, over 1 in. long, and open with elasticity so as to scatter the seeds to a distance. The leaves and flowers have an agreeable pungent taste, and may be eaten with other herbs in a salad.

[A. N. M'A.]

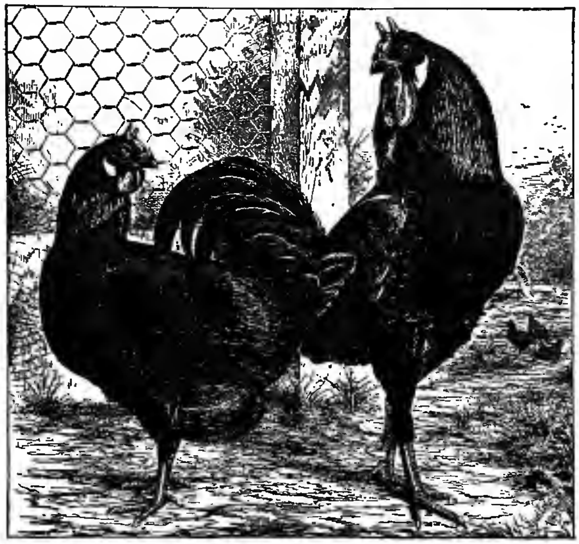
Læmophlœus ferrugineus. — This minute beetle is one of the numerous insects which attack stored grain. It is depressed, and bright fulvous, finely punctured, and clothed with short ochreous down; the head is large, with two little black eyes, and two straight eleven-jointed antennæ; the thorax is squarish; the wing cases have six indistinct ridges, and conceal a pair of ample wings.



1–4, Læmophlœus ferrugineus. 5–8, Tenebroides mauritanicus. The beetles and their larvæ, natural size (1, 3, 6, 8) and enlarged (2, 4, 5, 7).

Tenebroides mauritanicus is another corn-feeding beetle. [J. C.] [C. W.]

La Flèche Fowl.—This fowl is extensively bred in the La Sarthe department of north-western France, in the neighbourhood of the town bearing the same name. It is distinctive in character, being large in size, and entirely black in plumage; the head is ornamented by a horned comb, giving it a peculiar appearance. The birds are somewhat slow in growth, and are chiefly kept for fattening, as they produce very fine birds in the autumn and winter months. The flesh is abundant, delicate in texture, and the skin fine and white. The hens are good layers, but as a rule they are found to be somewhat susceptible to cold and rain, and in consequence they have not found a great amount of favour outside their own district. That they are among the finest of table poultry cannot be questioned, and some of the best specimens which are to be found in the Paris markets at Christmas and just before Shrove Tuesday are of this race. A few have been kept in Britain, where they have proved, under favourable conditions, very satisfactory. [E. B.]



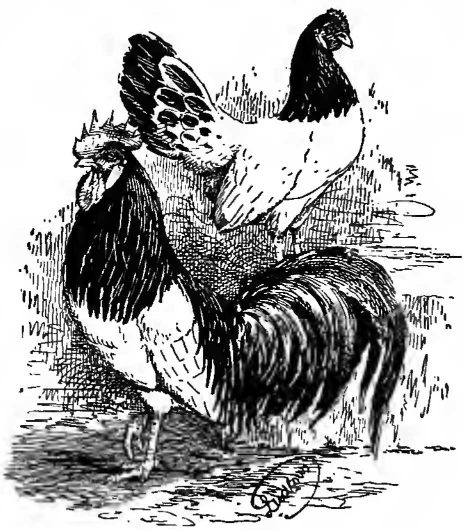
La Flèche Fowls

Lagurus ovatus, or **Hare's-tail,** is a very handsome annual grass which grows wild on the seaside sands of Guernsey and all round the Mediterranean coasts. The plant is composed of a tuft of hairy erect shoots under 1 ft. in height. The ears produced in early summer are white, egg-shaped, flat spikes clothed with soft hair, about 1 in. long and over ½ in. broad. The spikelet is one-flowered, with a membranous husk (lower pale) split into two parts with awned points, and bearing on its back a third awn. The chaff (glumes) of the spikelet is composed of two very narrow valves, tipped with a soft feather-like point. The awns of the husk and the feathers of the glumes give a light feathery appearance to the ear as a whole. Hare's-tail is sometimes cultivated for the sake of its ornamental ears, which are used for forming bouquets, for filling vases, for decorating ladies' hats, &c. For such purposes the grass is cut before the ears are fully ripe, then dried, and coloured to any desired tint by means of dyes. [A. N. M'A.]

Lakenfelder Fowl.—This breed probably owns the same origin as the Campine found in the Netherlands, and is kept largely in East Friesland, Germany, although at one time it was popular in Hanover. It is a small-bodied bird, well developed in the egg organs, and laying fair-sized white-shelled eggs. It is said that some of the specimens will produce as many as 150 eggs per annum. The peculiarity of this breed is that the body of both male and female is pure-white, whilst the head, neck hackles, and tail are black. In no other breed is this peculiar coloration to be found. The birds are active in habit, small eaters, but excellent foragers. They do not bear confinement very well, as they are rather wild in disposition. Although some of the hens become broody, still at the same time they are generally included in the non-sitting family. Up to the present this breed has been kept in Britain chiefly for exhibition purposes. [E. B.]

Lambing. See Parturition.

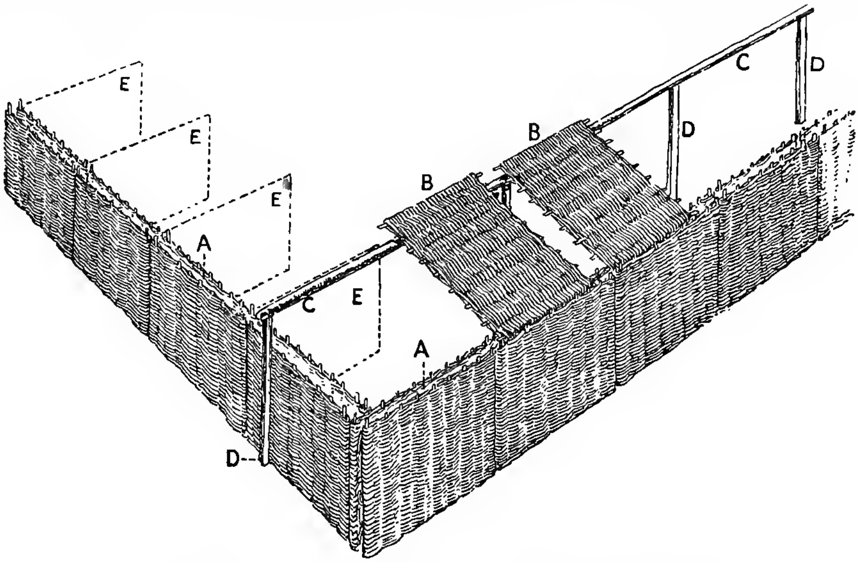
Lambing Pens.—Lambing pens vary considerably in their construction, the most elaborate being found in open districts where



Lakenfelder Fowls

the ewes lamb early, and where protection from wintry weather has to be provided. In some districts permanent yards of substantial materials are provided, but for hygienic reasons it is preferable to use temporary ones. The best temporary yards are made on the Wilts and

Hants Down farms; and the arrangement of the cropping provides that an old seed ley shall supply a convenient stack of hay, and firm soil on which to place the pen; a wheat-straw stack for shelter and for litter; while close by is a field of swedes or other root crop on which to turn the ewes and lambs as much as weather permits. The yard is almost entirely constructed with materials found on the farm; and its dimensions and divisions are regulated by the size of the flock, being more numerous if a ram breeding flock is kept, for it is customary to separate the ram lambs from the ewe lambs at the earliest period, and again to keep twin lambs apart from the singles; further, to divide them according to age. In this way, lambing pens sometimes cover as much as two or more acres. A simple division, however, is four pens set about a long straw stack; the two with the northern aspect being set apart for ewes about to lamb, and the ewes in these being drawn as nearly as possible into two lots, one for the forward ewes, and the other for the more backward. On the south side of the stack one pen is kept as the actual lambing pen, the ewes being run into this as they show imminent signs of lambing; and the other as a pen for those already lambed. The essential feature of all kinds of lambing pens



Down Lambing Pen: Outline of construction of yard, showing essential details

The yard is constructed of wattle hurdles set in double rows round the pen, the interspaces (A) being filled in with straw. B, Hurdles placed on incline from top of hurdles at back to supporting bars C, which rest on uprights D. Straw is laid on these hurdles to form a thatch and shoot water to outside of the pen. E, Dotted lines show small pens or coops for ewe and lamb. A hurdle is set up in front to enclose it from rest of yard. These coops are sometimes roofed, at others not. With wattle hurdles lambs cannot creep through, therefore one is sufficient for a division.

is a number of small pens or coops about a hurdle square in which to place each ewe and lamb, and especially the ewe with two lambs, so that they may not be overlooked, or for any other purpose as required. In setting out a lambing pen it is customary to set up a double row of hurdles on the outside, and to pack these with straw, and to make the inside divisions with single hurdles, the wattled hurdle used on the Downs being specially suitable, as the close wattling prevents the lambs escaping. On the inside of the rows of hurdles, lines of posts are set up about 5 ft. high and about 4 ft. from the line; on these, light battens or rafters are nailed; then hurdles are laid from these to the back row of hurdles, to form, when covered and thatched, a roof which shoots the wet outside the pens. Further developments are merely extensions of these pens. Towards the end of the season the straw used for sheltering is gradually used for litter; and in every way this is a most economical and convenient form of yard. In the eastern counties two rows of hurdles are set up at some distance apart through the centre of the yard, and between these straw is packed; leading out from these at right angles, the dividing hurdles to form the coops are set up, and over these on both sides other hurdles are laid lengthwise; straw is then built out over these from that between the hurdles, a roof formed and thatched down. This involves no expense beyond labour. Other yards are made on less systematic lines, and with material suitably at hand; but the two methods described are the best examples. [W. J. M.]

Lambs, Rearing and Feeding of.—This article deals with the rearing and feeding of lambs up to the age of nine or ten months, after which they are known by some other name than lambs. The rearing of lambs is a comparatively simple matter, as lambs of every breed are, without exception, reared on their mother's milk until able to maintain themselves upon grass or some other succulent forage. The

details of management differ according to the breed and the time of lambing. Hill lambs, which are dropped in April or May, require little attention after they are on their feet and have sucked once or twice. Lambs of low-ground breeds raised on arable land are more delicate, and, being born earlier in the season, require shelter and more care.

Shelter.—Shelter is generally provided for ewes and lambs when lambing occurs earlier than April 1st. The shelter sheds may be permanent or temporary. The former have the advantage of being better equipped, and are generally near the steading, and have a suitable house for the shepherd and his assistants. The drawbacks are the necessity for carting turnips and hay to the sheds, and the difficulty of keeping them perfectly clean and free from disease contamination from year to year. Temporary shelters may be erected against a wall or hedge near a turnip field and adjacent to a stack of hay which has been built there during the previous hay season. Labour is thus saved and a clean site provided each year, but the labour and time occupied in erecting the sheds may counterbalance the work of carting hay and turnips to the homestead.

Temporary lambing pens are made by erecting hurdles or flakes, with straw wound through them, on the exposed side of the enclosure; similar hurdles form the roof and ends, and the sunny side is left open, but is subdivided by smaller hurdles to allow the separation of ewe and lamb from the rest of the flock for a short time. The whole enclosure can be made snug and comfortable by running two lines of wire netting, about 12 in. apart and stuffed with straw, round a suitable area in front of the pens.

The ewes are brought into the enclosure at night, and each ewe as she lambs is placed in a pen for a few hours or days, according to the weather.

Twinning.—When it is desirable to put a strange lamb to a ewe whose own lamb is dead, it is only necessary to rub the slime from the dead lamb on the stranger if the ewe has not already licked her own lamb. If she has done so, however, several methods may be adopted, such as fastening the skin of the dead lamb on the strange one, or rubbing the nostrils of the ewe with whisky, or rubbing the nostrils of the ewe and the back of the lamb with some strong-smelling fluid. If those attempts fail, the ewe may be put 'in irons' for a day or two. A ewe 'in irons' is tied to one end of her pen close beside the hurdle on the near side, and a board or rail fixed along her off side parallel with the hurdle, so that she cannot turn on the lamb or swing her body away from it when it attempts to suck. A few hours of this discipline will generally induce the ewe to accept the lamb. Weak lambs should be taken to a warm place, but not too near a fire, and given some warm cow's milk with a teaspoonful of nitre in it. In a few hours they will generally be strong enough to join their mothers. At two or three weeks old, male lambs intended for stores are castrated, on a mild, damp day if possible, and not during frost or a hot sun. At the same time their tails are docked, if they are not of a hill breed. As a rule, lambs require no further attention till they are weaned, except care to keep them on clean pastures, frequently changed if possible, and watchfulness to remedy 'fly' attacks. Weaning takes place in June, July, or August in store flocks, but many lambs are sold fat while still with their mothers.

Feeding.—The rearing of lambs is conditioned more or less by the time which it is proposed to put them on the market, and it will now be convenient to treat of the lambs as prospective feeding sheep. Lambs are fattened off at ages which range from a few weeks to twelve months, and according to the age at which they are to be finished they are bred and fed. In proportion to the consumption of food, lambs gain weight faster than older sheep, and at less cost per lb. It has been estimated that it costs 25 to 30 per cent more to produce a given weight in sheep than in lambs; and as this disparity has been realized, sheep have been bred for earlier maturity and lambs have become more popular for turnip feeding in winter. Systems of lamb feeding are easily divisible into three, according to whether the object is to provide house-fed Christmas lamb, early fat lamb, or autumn mutton.

Feeding for Christmas Lamb.—This is the highest art of the sheep feeder, and requires the greatest skill and care. The lambs must be dropped some months before Christmas, and as this is contrary to the habit of the sheep, only one or two breeds are available. Of those, the best is the Dorset Horn, which will accept the ram at almost any season, and can, if necessary, breed twice a year. For the Christmas market the lambs are dropped in September or October and fed in the house. The ewe is liberally fed to induce a large flow of milk, and for this purpose cabbages and white turnips, along with cake and corn, are essential. Each ewe and its lamb or lambs is provided with a separate pen, warm and well-littered. The lamb is offered whatever it will eat as soon as it is inclined, and nothing is better for it than ground linseed cake, bruised oats, maize, and locust beans. Lambs well managed on this system, with good mothers, will be ready for the butcher at twelve weeks old, weighing 10 to 14 lb. per qr. They will then make the highest price in the London market. House-feeding Christmas lamb requires Dorset Horn ewes, suitable buildings, expensive food, and ceaseless attention to be thoroughly successful.

Feeding for Early Fat Lamb.—Lambs for the early fat market are not necessarily housed unless dropped early in January. The breeds or crosses most in favour for the early market are half-bred or three-quarter-bred or cross or mule ewes, mated with Border Leicester, Shropshire, Suffolk, or Oxford Down rams. The favourite cross is probably the half or three-quarter-bred ewe (*i.e.* progeny of Border Leicester and Cheviot, or Border Leicester and half-bred) with one of the Down breeds. The Down gives the dark face, quality of mutton, and firm, hard back desired by a buyer of fat lambs, while

the ewe is a good mother and gives size and quick-feeding tendency. The lambs must be well cared for from birth. In Scotland the flock is given the young grass or 'seeds' as soon as growth begins; in England the flock goes upon swedes, followed by winter barley, trifolium, and vetches. In Scotland the ewes are generally a 'flying' flock; and as they are to be fed off with the lambs, both dam and off-spring are given box feeding, consisting of linseed cake as the foundation, but a complex mixture of many ingredients will be found most effective. A very good lamb food, which is cheaper than cake, fattens quicker, and is equally suitable for ewes or lambs, may be made up of equal parts by weight of linseed cake, decorticated cotton cake, bruised oats, maize, peas, locust beans, and malt combs. If the cotton cake is broken large the lambs will not eat it, and danger from indigestion is thus avoided. In England the ewes generally belong to a 'standing' flock, and are therefore not fattened off. In this case the lambs are allowed, by means of suitable hurdles or 'creeps', to forage ahead of the ewes on the young second-growth turnip tops and the fresh rye and trifolium. They are also fed in separate boxes on better food. The ewes, confined within hurdles, get hay along with green forage, and a limited quantity of box food if necessary. The flock is frequently moved from one kind of forage to another, eating rye part of the day and winter barley later, &c. The system of folding sheep on summer forage crops is complicated, and cannot be described here except in general terms.

Well-bred lambs on young grass should be all marketed in May or June, and their dams should follow them in a week or two. English lambs on the folding system are generally kept longer, and attain to great weights in August, when they are consuming $1\frac{1}{2}$ to 2 lb. of cake and corn per day, and in their latter stages may lay on 1 lb. per day of live weight. At no period of their career are they run on grass, a daily turn on clover aftermath being the nearest approach to it.

Feeding for Autumn Mutton.—In the south of England, lambs, hoggs, or tegs are continued on the system described above until they are ten months or a year old; but in the north and other parts of England and in Scotland lambs are purchased from store farmers at the autumn sales, and fed off on the better land through the autumn and winter. The majority of those lambs are crosses of some hill breed with low-country rams or three-quarter-breds, or crosses of Down breeds with low-country whitefaced long-wool ewes. The lambs purchased in August or September are dipped, if not already dipped, and placed on good fresh grass or clover foggage. Neglect to give the lambs the best pasture will be disastrous at this time. Three-quarter-bred lambs are fed off before Christmas, as they sell badly afterwards, but Down crosses and half-breds can be fed longer without loss of quality. Good big lambs in forward condition are given box feeding as soon as they settle, and when the pasture or foggage becomes bare, cabbages and white turnips are carted on. When these are eaten, the lambs are folded on the turnip field on green-top yellows. They thrive best if kept in small lots of not more than a hundred, with comparatively little room to move about, and once on the arable land they will do best if kept there until they leave for market. The general routine of feeding includes a ration of cake or corn the first thing in the morning, then a small feed of cut turnips, followed by further supplies of cut turnips during the day; the second feed of cake and corn is given about three in the afternoon, with later on a sufficient supply of turnips to last the sheep till morning. The best results are obtained if turnips are cut, if cake is fed in small quantities at first and gradually increased, if it is well broken or bruised, and if shelter can be provided.

THE CONCENTRATED FOOD.—The choice of feedingstuffs for lambs on turnips is comparatively limited, and the chief foods in common use are linseed cake, maize, and oats.

Of all single foods linseed cake, if of good quality, is the best; but nearly all experiments go to show that a mixture of foods is better than any single one. Oats alone is undeniably a poor and unsuitable food for sheep on turnips. Oat-fed sheep fatten slowly and kill light, with an abundance of loose tallow. Barley and maize are in the same category, though on the whole superior to oats. Maize fed alone, economizes turnips, but is not well balanced, and is apt to vary greatly in composition. One of the best foods for sheep is dried grains, which are wholesome and liked by sheep, and on which they seem to thrive remarkably well. Bombay cotton cake, as shown by recent experiments, is highly profitable; but in general it may be stated with assurance that the best results are obtained from a mixture, and the preponderating items in the mixture should be dried grains, decorticated cotton cake, maize, and linseed cake. One with great experience in sheep fattening has suggested that in the first month on turnips the sheep should receive equal parts cotton cake and maize; during the second month dried grains should gradually take the place of maize, until the mixture becomes two parts of dried grains to one part of decorticated cotton cake; during the third month the cotton cake should be gradually replaced by linseed cake. By using such a mixture it is assumed that the sheep would first grow in size and flesh, thereafter increase in flesh and fat, and finally acquire from the linseed cake a bloom and finish. It is doubtful if hay is profitable when fed to sheep along with cake and corn. In some districts no hay is given, in other parts it is considered indispensable. On the whole, the evidence goes to show that hay is unnecessary. [R. B. G.]

Lamb's Lettuce (*Fedia olitoria* or *Valerianella olitoria*), also called Corn Salad, is a diminutive succulent annual weed of cornfields, belonging to the nat. ord. Valerianaceæ. The plant has a taproot from which the air stem rises, and though it forks repeatedly it reaches a height of only 2 or 6 in. The leaves vary from 1 to 2 in., and are spoon-shaped. From April onwards the plant is in bloom. The

flowers are minute, and are crowded in head-like pale-blue clusters at the ends of the stem branches. Lamb's Lettuce makes excellent salad, and is often cultivated on the Continent for saladmaking. [A. N. M'A.]

Lamb's Quarters.—The popular name applied to the annual weed botanically called *Chenopodium album*, and described under its common name in the article GOOSEFOOT.

Lameness is of frequent occurrence among the lower animals, and arises from a great variety of causes, some of them constitutional, others accidental, not a few being induced by adverse conditions of life, and invited by defective conformation. No species of domesticated animal, in which we include poultry, is exempt; but the importance from an economic point of view is very great. Lameness in the horse may render him practically useless, while the pig or dog may only be inconvenienced. In all lame quadrupeds it has been observed that when lameness affects a hind limb there is more constitutional disturbance than if a similar disability exists in a front one. This is worth bearing in mind both by the horse-keeper and stock-owner who is called upon to decide whether he will submit to long and costly treatment, or cut his losses by slaughtering an incapacitated animal. To take a common example or two, we may point to the case of a horse pricked in a front foot, and another in a hind one. Assuming that the measure of pain and consequent lameness is equal, the animal injured in front will scarcely lose weight in a week; while the victim of a similar injury to a hind foot will lose flesh and have a contracted abdomen in three or four days, this condition being familiarly known as 'tucked up' in the flank. A bullock will go on fattening, and a cow yielding nearly a normal amount of milk, while suffering considerably in a fore limb; but a similar lameness behind will put a period to laying on of flesh, and seriously reduce the secretion of milk. While a subject of footrot is only affected in the front feet, and prefers to kneel in order to graze, he will hold his own; but if the disease extend to the hind feet and cause pain, the sheep will not pay for maintenance. It is assumed that nervous influences reflected from the hind limb to those trunks concerned in digestion are responsible for this result, but the *modus operandi* is not so clear as the fact that it in some way produces the effect above mentioned.

Constitutional lameness may be due to rheumatism, to infectious joint evil, to transferred congestions, or what is known as metastitic lameness; to tubercular deposits, secondary abscesses, to quarter ill, Monday-morning leg (inflammatory œdema), purpura, and other blood diseases. Adverse conditions, such as close confinement, give rise to congestive troubles in the feet and limbs, particularly in the joints, whose synovial membranes fail to secrete the proper quality and quantity of lubricating fluid without the stimulus of exercise. Many cases of lameness in farm horses would be avoided if the importance of exercise were as fully realized as the desirability of rest and recuperation after the seasons of special activity; indeed the need of a few minutes' walking exercise is greater the day following severe work in the plough than at other times, as it will be readily understood that active secretion of synovia on one day should not be followed by stagnation the next: hence the advisability of a few minutes' walking exercise when a stiff and reluctant animal would prefer to remain in the stable. Laminitis, fever in the feet, coronitis, navicular disease, thrush, and foul or loo in the feet of horses and cattle respectively are largely due to standing in the stall for long periods. Horses suffer more than cattle from the lamenesses due to confinement, as they seldom lie down in the daytime, and their small brains need no more than four hours' sleep at one time. Ruminants spend more time in a recumbent posture, and dogs with their relatively large brains require and take a great amount of sleep. Horses that are stabled; cattle, sheep, and swine confined in small spaces, and standing upon their own ordure and lying upon decayed bedding, contract diseases of the feet and joints of the lower limbs, and the spreading of dry litter upon a wet floor is not enough protection. Similarly many cases of joint lameness in swine prove to be due to saturation of the soil under the sty whether or no a surface of boards or a cold, but usually broken, stone or concrete surface has been laid. Defective conformation leads to lameness in those animals compelled to labour, as the horse, ass, mule, and working ox, and the liability to fall lame is proportioned to the pace or severity of the task. The importance of conformation cannot be overestimated, and we are but inviting lameness when we call upon a horse with loaded shoulders and heavy forehand to do fast work, or ask a bloodhorse to draw heavy loads. The short pastern and upright shoulder lead to greater concussion than is felt by the long and oblique pastern and shoulder with similar inclination, and the sickle hock will be liable to curb, as the straight one will to spavin. These are but examples of the risk we run of lameness as the result of defective conformation. When we have eliminated all probable or contributory causes by not breeding from or purchasing animals that are unsound or wanting in proportion, and have kept them under hygienic conditions, there will still be many accidental cases of lameness having their origin in accidents, genuine and so-called. The treatment of lameness must be preceded by a correct diagnosis. There are many cases so obvious or palpable that the veriest tyro will have no difficulty in pronouncing on the limb affected, perhaps the portion of it injured or suffering; but the discovery of the seat of lameness in others will tax the powers of the most skilled veterinary surgeons, and it is no uncommon thing for experts to disagree as to the cause. Nevertheless the majority of persons connected with animals approach the diagnosis of lameness with a confidence seldom justified by results. Experienced grooms are not infrequently discovered medicating the wrong leg, or treating a foot lameness by rubbing liniments into the shoulder. We would here describe some of the methods of

diagnosing lameness, and refer the reader for the treatment of particular lameness to arts. on Foot, Diseases of; Bone, Diseases of; Sprains, &c., all of which are to be found under their respective headings. First then as to diagnosis, and assuming that the horse is most often lame, more valuable than other animals, and that his conduct when disabled in a member is typical of the same trouble in other species. Unless the cause is obvious, we should have the animal led out in a halter with a long free end or tag. If a bridle is held too short, the horse at a trot will keep his head turned towards the leader, and this will often make him appear to 'nod' in that direction, and suggest lameness of the off fore limb. This is so well known as to have received the name of 'bridle lameness', and, we may remark, only occurs when one's own man is running him for inspection. If the seller's man is performing this office he may take the bridle so short under the horse's chin as to deter a lame animal from nodding. This perhaps is still better known to dealers than so-called 'bridle lameness'. A couple of feet of loose rein or halter tag disposes of these difficulties. As the horse is trotted away from us, we should watch the level of his hind quarters, and note if he drops more on one side than the other. As he returns we should watch his head and neck, and note if he drops or 'nods' to one side more than the other. It may be necessary to repeat this performance before we can decide upon which limb he is lame; nor must we forget that the one he drops or dwells on is *not* the lame one, but that upon which he imposes the least weight and rests on the shortest time. Having decided upon which limb is affected, we proceed to examine more closely. A careful manipulation may discover a hot or tender place or swelling in any position from the top to the bottom of the limb, but the number of lamenesses above the knee and hock are few as compared with those below it. Under the pressure of the finger and thumb a horse will flinch with a recently formed splint or bruised shin, and puffiness or undue heat in a tendon or fetlock joint will be detected by a sensitive hand. It frequently happens, however, that nothing can be seen or felt, and the foot may be perfect in shape and normal to the touch, yet the animal is decidedly lame, perhaps very lame; and the old adage should be remembered to 'have the shoe removed even if a horse is lame in his head'. So many cases turn out to be in the foot, that we should never neglect this precaution unless absolutely convinced that the trouble is elsewhere.

We have said that foot lameness is often attributed to the shoulder; but this mistake would not be made if the examiner bears in mind the fact that any immobility in the latter region causes a dragging action of the limb—the toe is brought forward with difficulty, and in marked cases strikes the ground on the front aspect of the hoof. In the majority of foot lamenesses the animal 'points', or places the suffering member in advance of the other foot, which is conduct quite the reverse of that of a horse lame in the shoulder. Sometimes he knuckles over at the fetlock to lessen the weight and ease the pain, and if suffering very greatly, as when matter is confined within the hoof, will be seen lifting it off the ground at frequent intervals, doing just what he would find most difficult if the shoulder were involved. Some doubt remains when the horse does not point, but has a short stilted action. We have to weigh the chances, so to speak; and remembering that shoulder lameness is rare, and generally traceable to collision with doorposts or other objects, and that foot troubles are the most frequent of all, we shall explore that portion again and again before being satisfied that the lameness is elsewhere. If the elbow or the knee is the site of lameness, there is a disposition to turn the limb outwards when trotting; and this is perhaps best seen by stooping near the ground and watching between the animal's hind legs as he is moved from the examiner; then taking up a position in front, which may confirm or disarm his suspicions. It is generally thought to be more difficult to diagnose lameness in a hind limb than in a front one. Unequal use of the hind limbs may result from injury in the spine, the pelvis, or the hip joint by which the limb is hinged to the trunk; and these injuries are often very puzzling to experts themselves. Sometimes examination *per rectum* enables the surgeon to diagnose fracture of the arch; more often this is discovered *post mortem.* The ball-and-socket joint or true hip is not often the seat of lameness unless from external violence, when a diagnosis is helped by knowledge of the circumstances under which the accident occurred, or by abrasions in the vicinity of it. When grooms speak of lameness 'in the round bone' they point vaguely to the quarter, which may be intended to refer to the hip or to the stifle joint, which latter corresponds to our knee and is a frequent seat of lameness, especially in leggy, overgrown colts that have done badly on rough, hilly pastures. Whether lame from over-extension of the ligaments or other cause in connection with the stifle joint, the action or movement of the limb when the animal is compelled to walk, and particularly if made to trot, is diagnostic, the whole limb being thrown outward in the arc of a circle. In the luxation of colts, the patella bone may be heard to go back into its place with a clicking noise.

Treatment of the particular lamenesses must necessarily depend on the causes, and these causes are considered under the various diseases of the feet, the bones, tendons, and other structures. Removal of the cause is the essential thing, and readers are cautioned against instant resort to advertised panaceas, which often obscure the nature of the lameness and do injury, where a cold-water bandage would have had the desired effect. We have known veterinary surgeons deceived by the inflammation produced by terebinthine liniments, and pus to be forming in a foot, while some portion of the limb was being thus treated. [H. L.]

Laminitis, or **Fever in the Feet: Founder.**—Horses and other animals, the ox, the sheep, and the pig, are liable to inflammation of the tissues connecting the hoof with

the bones of the foot. The laminæ which fit into both are extremely sensitive, and, as may be seen in the illustration, carry an enormous amount of blood through a vast number of

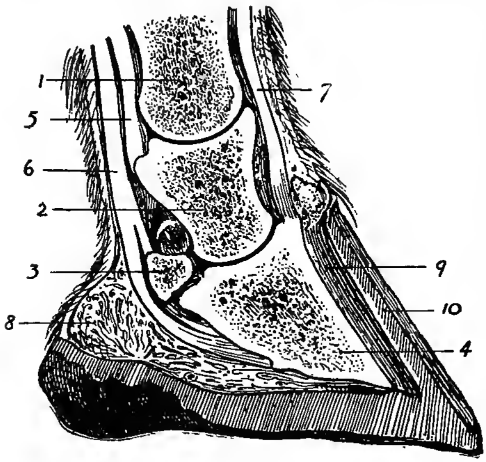


Fig. 1.—Section of Horse's Foot, showing position of the Laminæ

1, Os suffraginis. 2, Os coronæ. 3, Navicular bone. 4, Os pedis. 5, Perforatus tendon. 6, Perforans tendon. 7, Extensor pedis tendon. 8, Plantar cushion. 9, Sensitive and horny laminæ. 10, Anterior wall of hoof.

vessels to and from the foot, with many passages or foramina in the bone itself. To the horseman with a general outside knowledge of the foot and its good and bad points, it comes as a surprise the first time the internal structure is examined; and this great distribution of vascular membrane enables him to understand at once how serious must be any congestion in such a network of vessels confined within a rigid box of horn, where no relief can be obtained by the usual swelling which takes place in other parts of the animal. The sensibility of the laminæ compares with the under surface of the human nail, and of this most of us have had experience at some time or other by a thorn or other sharp body's intrusion. On account of his great value and importance, laminitis in the horse has been the subject of much enquiry; but animals not generally employed for labour are subject to laminitis, and occasionally cast their hoofs before the real nature of the malady is recognized. The heavier breeds of horses with their slower circulation are more prone to fever in the feet than the lighter, unless we except those with extravagant action, and suffering more by concussion. Entire horses are specially prone to laminitis when commencing their season's travels, and many are finally taken off the road owing to the obvious founder of their feet.

Causes.—Hereditary predisposition is generally recognized, but this probably has something to do with the heritage of comparatively flat feet with low, weak heels, which easily lend themselves to bruising and consequent injury resulting in inflammation. The best-formed feet are by no means immune. Bad management accounts for a large proportion of cases; hence we find the overfed pet pony, seldom used and carrying a superfluous load of fat, to incur the disease without apparent provocation. So with the fast-trotting cob of the sporting publican, indulged in much corn and driven fast and far on holidays, with long intervals of idleness. Certain foods predispose to fever in the feet, and among them may be mentioned maize, wheat, beans, peas, and barley. New wheat is particularly feared on this account, and barley, which was formerly the staple grain for horses, gave place to oats chiefly for this reason. It should perhaps be said here that the above remarks apply specially to our own islands, and are not of universal application; as in America, Australia, and other climates less humid, or not having the peculiarities of our own, competent observers declare that a diet chiefly composed of maize or wheat may be continuously furnished without these consequences. High feeding, want of regular exercise, and too fast or prolonged work at other times will account, then, for a majority of cases. There is, too, a peculiarly intimate relation or sympathy between the mucous membranes of the respiratory and digestive tracts with the soft vascular covering of the foot bones, the laminæ. An attack of congestion of the lungs in the hunter, after a fast run, may result next morning in laminitis—'fallen in his feet', as the stable phrase has it; or the administration of an aloetic ball under certain conditions may have a like

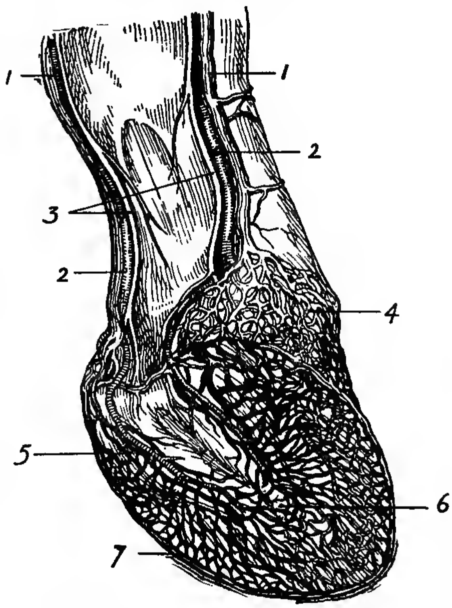


Fig. 2.—Blood Vessels of the Sole and Frog

1, Digital vein. 2, Digital artery. 3, Posterior digital nerve. 4, Coronary plexus. 5, Plantar artery and vein. 6. Semi-lunar anastomosis. 7, Circumflex artery.

result. Abdominal inflammations are sometimes relieved at the expense of a resultant pain in the feet; laminitis may also occur as a sequel to foaling. In cattle, sheep, and swine it may

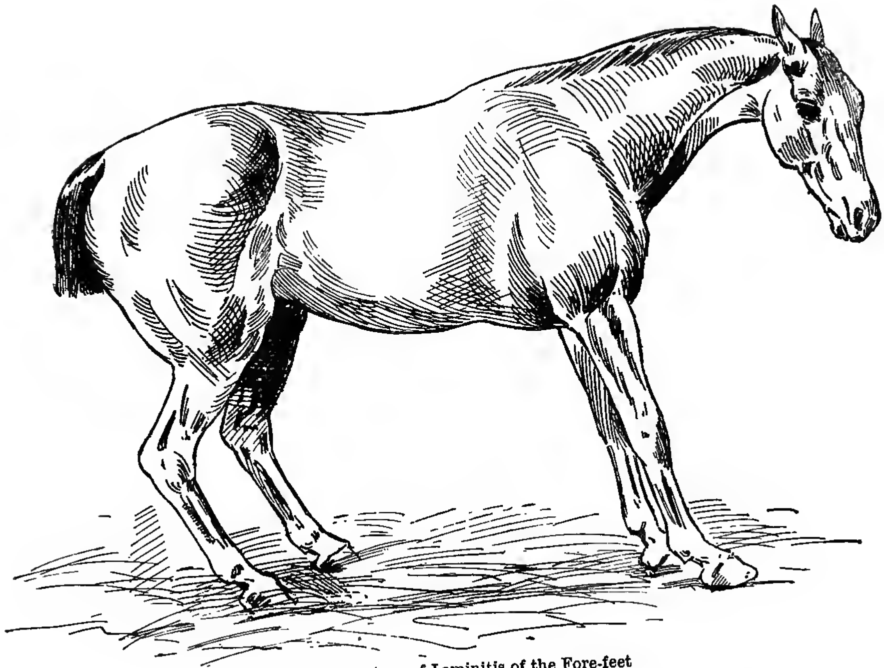


Fig. 3.—Posture of Laminitis of the Fore-feet

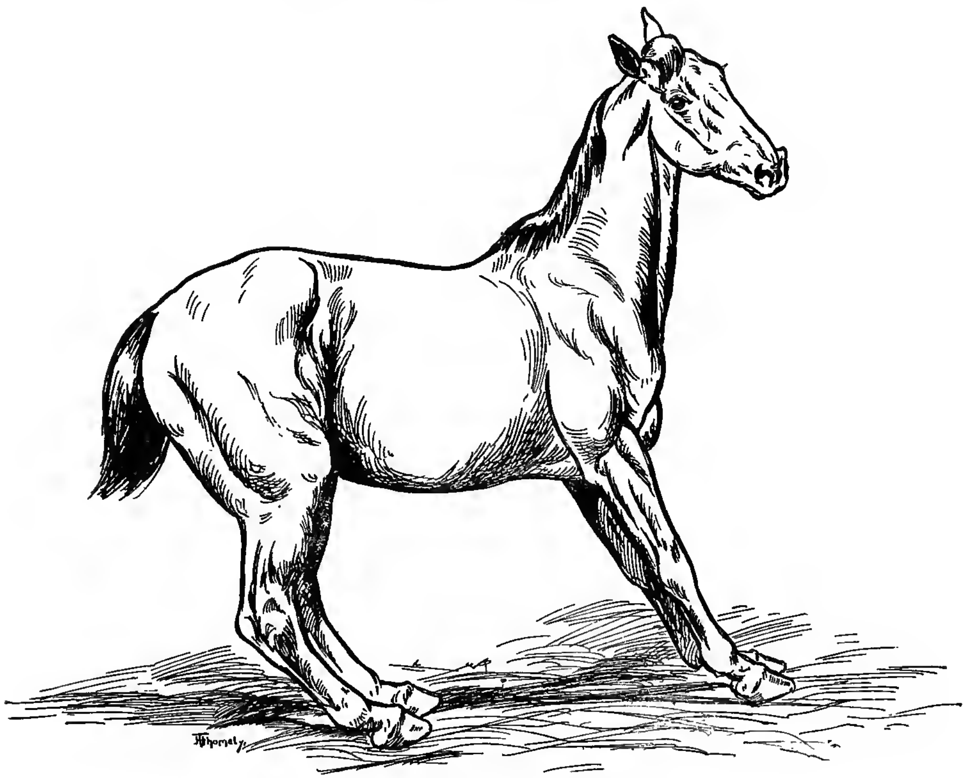


Fig. 4.—Laminitis in Fore- and Hind-feet

LAMINITIS

follow on parturition, acute indigestion, or chills which under other circumstances would result in catarrh and nasal discharges.

Symptoms.—Preliminary shivers (rigors) are seldom observed, nor is any suspicion aroused as a rule until the animal is discovered in the morning to be standing as if fixed to the ground, or else leaning back upon the heels. In the less severe cases, and where the front feet only are involved, the attendant often fears some injury to the spine, as the horse, when told to 'get over', endeavours to obey with only the latter half of his body, or sways as though fearful of falling. At the same time the hind feet will be observed to be placed farther forward under the body than usual. If taken by the halter and pushed back, the patient moves his head and body as best he may, but not his feet, leaning back upon the heels. If the animal is compelled to move, he does so in short painful steps, and with a facial expression denoting very great agony. To this may be added hurried breathing, increased temperature, a hard quick pulse, and patches of sweat about the body. The membranes of the eyes and nose are deep-red; the hot and clammy mouth and constipated bowels all indicate the high fever and pain that are endured. In this, as in some other maladies, horses will not lie down, and finally fall down—too often to rise no more. A recumbent posture would greatly ease the pain of fevered feet, but the animal's behaviour is interpreted as fear of being unable to rise again. It is also a fact that horses die if long on the ground, contrasting strangely with cattle, sheep, and swine, whose persistence in remaining on the ground is attributed to paralysis, 'sulks', and anything but laminitis. When compelled to stand, these creatures behave in much the same manner as horses.

Laminitis is met with in many degrees of intensity, the symptoms varying from a little shuffling and evident uneasiness, to those described already in extremely bad cases. If early relief is not afforded, serious structural changes take place, and these of a permanent character. Separation between the coffin bone and the soft structures leads to the dropping of the sole, while at the toe and above it the hoof falls in. In a few instances the hoofs become detached and come away. Some horses make a partial recovery, but have a chronic low form of congestion, recognized as chronic laminitis; a condition which may also be seen in animals that have never suffered the acute form at any time, but which leaves its mark in the same formation of rings around the hoof, and a brittle or shelly foot. The toe gradually thickens, and in movement is turned upward to a greater or less extent. The heels become stronger and more capable of sustaining the increased weight thrown upon them.

Treatment.—A full dose of purgative medicine, preferably aloes, should be given in the form of a ball, this drug having a special reputation for withdrawing inflammation from the feet, and being known to the old practitioners as a 'derivative'. Here the lancet is demanded for a full blood-letting from the jugular vein, particularly in the case of fat animals. Slings relieve some of the weight and pain endured by the feet; many patients seeming to appreciate them, by assuming restful attitudes they would fear to take if not so supported. On the other hand, a few individuals will not tolerate slinging. Modern slings, with braces over the back and endless chain and pulley, can be so used as to permit the patient to lie down upon the good bed of straw which should in all cases be provided, while allowing the animal to be pulled up again by one person from time to time. A little rest gained by lying down is most beneficial, and horses soon learn the meaning of their attendant's efforts to raise them, and cease to offer that passive resistance which on the first occasion makes the raising of a heavy beast so difficult. If cattle are slung it must be only with the object of getting them up, or of preventing them from lying down; their digestive functions are interfered with if slings are so placed as to afford them any continuous support while standing. The smaller species of animals can and should be lifted on to their feet at least once a day, and turned on the other side when permitted to lie down again. It is always desirable to remove the shoes of horses—a somewhat difficult performance in many cases. Warm bran poultices should be continuously applied and frequently renewed. Intense pain, long-continued, may necessitate hypodermic injections of morphia, or by the same method half an hour's entire cessation may be gained by cocaine, during which the animal may be tempted to eat. With subsidence of the acute symptoms, cold-water irrigation will be substituted for poulticing; the patient will be encouraged to move in his box; perhaps be led to a pond near by, and allowed to stand in it for several hours daily. Gentle exercise daily on soft field or a tan ride will aid the restoration of function, and finally a blister from halfway up the cannon bone to the coronet is advised. When the limb can again be handled, a shoe of special construction should be fixed, which will allow of more weight being thrown on the heels than in ordinary shoes. The kind of shoe required is known as a seated-out rocking shoe, with plenty of cover. [H. L.]

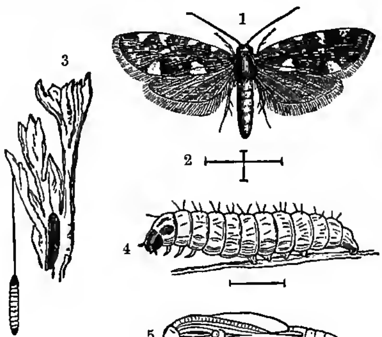
Lammas, one of the four quarterly term days in Scotland, occurring on August 1st.

Lampas and Lampas Paps.—Lampas or lampers, or lampas paps, are terms given to a swollen condition of the gums immediately behind the upper incisor teeth, but the meaning is sometimes extended to other parts of the mouth by those who recognize a gumboil as a pap. This state of the gums and anterior portion of the palate is usually due to teething, although it may be met with in older horses as the result of irritation when feeding upon gorse and other prickly things, or as extension of an inflamed gum due to lodgment of particles of food in the interdental spaces. In the colt it seldom needs any treatment beyond a few doses of bicarbonate of potash and nitre, or other simple saline; but in a few instances benefit will be derived by making two or three punctures in the swelling by means of a clean lancet or pocket knife, and exciting the flow of blood by

moving a finger or two under the tongue. 'Lamper irons' are still to be found in remote blacksmiths' shops, and were used to burn back the 'lampers', a custom so barbarous that it has been decided to be an offence under the Cruelty to Animals Acts — a fact not sufficiently well-known among horse-keepers. [H. L.]

Lampblack is a form of charcoal. It is prepared by burning compounds rich in carbon in a limited supply of air. Any carbonaceous compound which burns with a smoky flame is producing lampblack or soot. The black deposit which accumulates on the sides of a glass chimney of a petroleum lamp when the wick is turned up too high is lampblack. On a manufacturing scale lampblack is made by incompletely burning oil, fat, tar, resin, &c., in cast-iron or brick furnaces. The products of combustion, the smoke, is led into a chamber in which are suspended large cloth sheets, upon which the lampblack or soot deposits. Lampblack is carbon in a very fine state of division, and prepared as above it generally contains oily hydrocarbons, some ammonium salts, and mineral matter. The oily bodies and ammonium salts are removed by heating the lampblack to a dull-red heat, the mineral matter is removed by washing first with acid and afterwards with water. The purified lampblack is used for printer's ink, black paints, blacking, &c. [R. A. B.]

Lampronia rubiella (the Raspberry Moth) is a small insect, not quite ½ in. across



Raspberry Moth (*Lampronia rubiella*)

1, Moth (magnified); 2, nat. size. 3, Caterpillar (nat. size). 4, Caterpillar (greatly magnified and nat. size). 5, Chrysalis (greatly magnified).

the wings, which are brown, dotted with yellow. It lays its eggs in the fully opened flower of the raspberry, and the grubs feed in the 'receptacle', but do not prevent the fruit forming, or indeed do any visible harm during the first year. When the fruit ripens they leave it, to hide away for the winter, coming forth the following spring—still as caterpillars—to feed upon the buds, into which they burrow, completely killing the young shoots. The caterpillars are easily recognizable, being of a deep-red colour, and about ⅓ in. long when fully fed. They are smaller than this when they come out of their winter quarters in April and wander over the canes in search of the young buds. The same caterpillar may injure several buds, eventually turning to a chrysalis inside the shoot in May.

Treatment. — Removing and destroying the infested shoots before June; preventive dressing at the base of the canes in April to impede the caterpillars in their attempt to crawl up to the buds; cleaning the raspberry beds of all rubbish likely to afford winter shelter for the caterpillars. [C. W.]

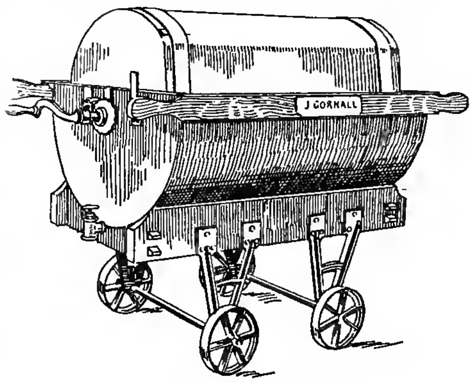
Lamps.—Lamps have been brought before the farmer's notice more prominently in recent years, because of the compulsion to use lamps on all vehicles sent on to the highways after 'lighting-up' time. Whether all animals shall be accompanied with a lamp when on the highroad similarly, is exercising the minds of those who drive high-speed motors. Lights on agricultural vehicles are regarded as necessary rather as warning of their presence than as of illuminating the way for speedier travellers, whose powerful lamps and reflectors have a paralysing effect on the sight of those who meet them. Previously to the introduction of motor cars few heavy vehicles carried lamps, and many urged that they could drive their course more safely in the darkest nights without them than when their vision was hazed by the glimmer of the candle, which provided little more light than reached beyond the horse's head. The candle lamp or lantern is still frequently used, but the introduction of cheap oil lamps suitable for lighting the way for bicycles is fast ousting the candle. The candle lamp was almost exclusively used on the farm until within the last thirty years, and it is only within comparatively recent years that oil lamps could be obtained in a cheap form sufficiently safe to be used among the straw and other inflammable matter. The horn lantern may still occasionally be met with. Simple lamps with solid round wicks seem to have been known for untold ages, but it was not until 1783 that Leger invented the flat, and in 1784 that Argand invented cylindrical burners, and these were rendered possible of use by the adoption of limpid vegetable oils. The French moderator lamp, still occasionally met with, was invented by Franchot in 1836, though expensive clockwork lamps had been made earlier. The moderator was the first really good lamp; but the introduction of mineral oils, such as paraffin, petroleum, kerosene, crystal, &c., among the lighter oils; and heavier, specially high class, known as mineral sperm and mineral colza, and many other proprietary names, afforded a new departure in lamps. In the making of burners the opportunities lie between flat and circular wicks. The flat wick has naturally the best supply of air and therefore oxygen, and is fitted with a slotted dome to deflect air to the flame, draught being assisted by a chimney about 8 in. or 10 in. high. In 1865 Hinks brought out the double burner and greatly advanced the value of lamps; and in 1874 Doty brought out a three-wick burner, with wicks set in triangular form, but with space between the sides, which was a further improvement, though not so generally adopted. In 1885

Defries made a great advance by introducing a burner which prevented the undue heating and danger of older forms of circular burners, for by using a thin metal casing enclosing a portion of the wick inside the oil reservoir, no oil or oil vapour could escape except by passing through the wick. This rendered the lamp suitable for farm and stable purposes, and since its introduction has been generally used. Neither glass nor china should be used for wells of lamps, as in case of accident the whole contents are emptied at once, and spreading rapidly carry the risk of fire far. Acetylene gas was first made on a commercial scale in 1895, and is now very largely used for road-lighting purposes on fast vehicles and motors. Carbide of calcium, when acted upon by water, evolves acetylene, and the acetylene lamp is constructed so as to provide that a constant and sufficient admixture of water with the carbide shall take place to generate the gas as it is required. It forms an excellent illuminant, but it is not so safe as oil when in a well-constructed lamp, and therefore should not be used where there is much inflammable matter about. [W. J. M.]

Lancashire Cheese.—Lancashire cheese is usually made in two shapes, one the large 'flat' shape, which is by far the more common; and the other the small 'Stilton' shape. The flat ones usually weigh from 40 to 50 lb. each, and the small ones about 12 lb. each. The texture of a good Lancashire cheese is quite different from that of a Cheddar, being freer and more open, softer, but not crumbly or spongy. One very important difference between a Lancashire and a Cheddar cheese is due to the different methods of developing acidity. In the making of a Lancashire cheese the acidity is developed more slowly than in the making of a Cheddar, a special feature being the retention of a portion of the curd until it is quite acid, and sour to the taste. This sour curd is finally mixed with a certain proportion of the new curd. The acidity is thus allowed, practically speaking, to develop naturally, a factor which assists very materially in giving Lancashire cheese its mellow character. The flavour of a good cheese is rich and full, often slightly acid, but mild, and is greatly appreciated by the industrial workers of the great Lancashire towns. The disagreeable biting flavour which is found in what is known as 'binged' cheese is decidedly objectionable. A very special feature of a good Lancashire cheese is its 'toasting' property. When carefully subjected to heat, the fat and the casein melt down and the component parts become intimately mixed together, forming a soft, rich, custard-like substance of delicious quality. This special property of 'toasting' was apparently ascribed by the older makers to the fact that the cheese was salted from outside instead of being put into brine, as were the ordinary cheeses at that time. It is interesting, however, to find one old writer stating with commendable insight that the property of the parts of the cheese 'mixing together when hot is due to their being put together cool when made'. This statement has more in it than at first sight appears, and probably accounts in a great measure for this special feature of Lancashire cheese.

In comparison with Cheddar cheese, Lancashire cheese contains more moisture, and consequently does not keep so well, but it is a profitable cheese to make, as about $1\frac{1}{8}$ lb. of uncured cheese can be obtained on the average from a gallon of milk; and it is usually marketed comparatively soon after it is made.

Method of Manufacture.—The cheese is made from the mixed evening's and morning's milk, usually without the abstraction of any cream. In the hot months of summer the evening's milk is cooled, but in colder weather no cooling is required. There is no hard-and-fast rule as to the minimum temperature required when cooling the evening's milk, in fact the milk on some farms does not need cooling at all. Generally speaking, however, the milk is

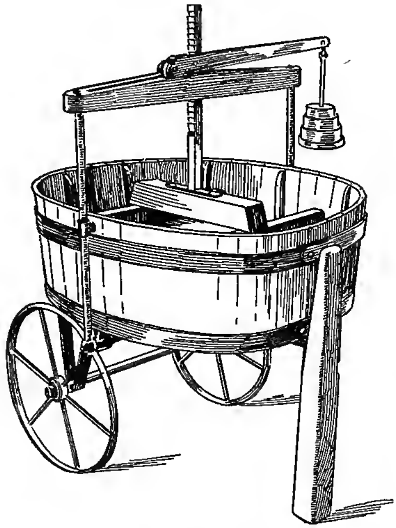


Patent 'Cheesemaker'

cooled in summer down to a temperature between 65° F. and 75° F. according to circumstances. In the morning the cream is skimmed off and heated a little, and returned to the 'cheesemaker' through the strainer along with the morning's milk. The mixed milk is then warmed up to the temperature at which rennet is added. Formerly the milk was received in a large wooden tub, oblong in shape with rounded corners. There were several objections to the use of this tub. It was often allowed to rest on the floor of the dairy, with the result that a variation in temperature often occurred between the upper and lower portions of the milk; and again, the person taking off the whey from the curd had to kneel on the floor or bend over the side of the tub, both of which positions were attended with considerable discomfort. The removal of the whey was effected by lifting it out with a wooden bowl, and towards the end of the operation the whey was separated from the curd by pressing down on a wooden rack made for the purpose. In some cases the tub was in a raised position, which was an improvement, and the whey was allowed to drain away through a tap.

The old-fashioned tub is now superseded by Gornall's Patent 'Cheesemaker', as it has proved itself to be much more satisfactory. It has a water-jacket, which enables the maker of the

cheese to regulate the temperature of the milk in the cylinder, and it also allows of the whey being drawn off with a minimum of damage to the curd. In drawing off the whey a cloth is fastened over the opening, and the perforated lid is then fastened over the cloth. The cylinder is then turned over, very slowly at first, and the whey flows through the perforated lid into the jacket, from which it is drawn off through a tap. After turning down in one direction the cylinder is reversed, and then turned in the other direction, and so on until the operation is concluded.



Drainer Press

Colouring Matter.—At one time a very large proportion of the cheese made was coloured; in fact, many of the towns in the northern part of the county insisted upon coloured cheese. There is little or no colouring matter used at the present time, and the preference of the public for coloured cheese has disappeared.

Renneting.—The temperature of the mixed milk when the rennet is added usually ranges from 80° F. to 88° F. according to the season of the year. A higher temperature than 88° F. is employed in cold weather. The acidity in the mixed milk is at this stage about ·20 per cent. Sufficient rennet is used to give a curd firm enough to break over the finger in about an hour.

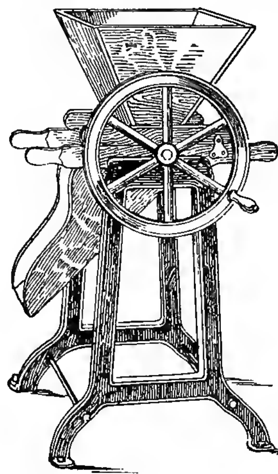
Cutting the Curd.—The curd is sometimes broken with the hands, but this method has very largely given way to that of cutting with knives. Sometimes one knife only is used, but it is better to use two, one having vertical blades and the other horizontal blades. The curd is then cleaned off the sides and bottom of the cylinder with the hand, and is allowed to settle in the whey for a time before the whey is drawn off.

Drawing off the Whey.—On testing the whey at this point it shows from ·13 to ·15 per cent of acid. The method of drawing off the whey has already been described. As the whey is drawn off, the curd becomes gradually firmer, and as soon as it is firm enough to lift without breaking, it is transferred to the drainer. The time taken for drawing off the whey is about an hour.

Draining the Curd.—Should the curd be too firm, it is advisable to open it up a little when placed in the drainer, but great care should be exercised in the breaking, and any squeezing of the curd must be avoided. The curd is allowed to drain a little before applying pressure. Later, the whey is separated from the curd by breaking, to facilitate drainage, and then by pressing gradually after each breaking. If the curd is fairly dry, about three breakings are sufficient. The time taken to dry the curd may be up to four hours, and at the end of the draining process the curd, if tested with the hot iron, shows strands of about $\frac{1}{8}$ in. in length. The whey which drains from the curd at this stage contains from ·23 to ·25 per cent of acid.

The Old Curd.—A certain proportion of the new curd is put away for use on the following day, or maybe in two or three days. This old curd is kept as far as possible at a uniform temperature, and each day's supply is kept about the same length of time, so as to avoid wide variations in the amount of acidity developed. The curd becomes very sour to the taste and smell, and when tested with the hot iron usually shows strands $1\frac{1}{2}$ or 2 in. in length.

Grinding of the Curd.—The new curd is ground when sufficiently dry, and mixed with a certain proportion of the old curd, which has also been ground. In the summer the proportion is often half new curd and half old; but in spring and autumn as much as two-thirds of the mixture may be old curd. In very hot weather the proportion of old curd is often as low as a third.



Curd Mill

Salting of the Curd.—Salt is added at the time of grinding, or immediately afterwards, and carefully mixed with the curd. The usual

proportion of salt is about 2 per cent of the curd. The old system of 'brining' the cheese is no longer practised. The operation as carried out by a Mr. Smith, Ellel, Lancaster, is described in Mr. Binn's work on Lancashire Farming, dated 1851, as follows: 'After being taken out of the vat the cheese is put into an earthen vessel, provincially a 'mug', containing about three gallons of brine,—the latter is occasionally cleared by being simmered over the fire, and skimmed; coarse salt is laid upon the cheese, on its being first put into the brine mug; seven of these mugs are required, and the cheese undergoes a regular process of being turned every day as it passes through the seven mugs in rotation, the salt being scraped off each time of turning, and put on again when turned. After the cheese has been placed in each of these mugs in regular succession, it is taken out of the brine and washed in warm water, wiped dry, and put on a shelf in the kitchen for four or five days; being turned once every day, and sometimes twice, in order that the brine, by the warmth, may ooze out before it is taken to the cheese room.'

Pressing of the Mixed Curds.—The ground 'old' and 'new' curds are carefully mixed and placed in a vat which is lined with a cloth. The temperature of the mixed curd should be about 70° F. The vat containing the curd is often placed in the cheese press, but no pressure is applied for several hours, but after a time the vat is turned over on to the lid. Pressure is applied at night or early the following morning. The cloth is generally removed on the morning of the second day, and the bandage applied. The cheese is subsequently returned to the press, and in some cases pressed for two days.

Curing Room.—After pressing, the cheese is taken to the curing room. The temperature of the room is maintained, if possible, at about 60° F. The cheese made on the lines indicated is usually ripe in from four to eight weeks.

[E. P.]